Clarendon Press Series

BACON'S NOVUM ORGANUM

FOWLER

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Clarendon Press Series

BACON'S

NOVUM ORGANUM

EDITED

WITH INTRODUCTION, NOTES, ETC.

BY

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AT THE CLARENDON PRESS

M DCCC LXXVIII

PREFACE.

This Edition of the Novum Organum is intended to supply a want which, I think, must often have been felt by students—namely, a commentary, which, besides explaining the difficulties of the work (by no means few or small), should also present Bacon in his relations to the History of Philosophy, Logic, and Science. That I have fully succeeded in meeting this want, I cannot flatter myself, but, at least, I have spared no pains in the attempt, consistent with the brevity imposed on me by the limits of a single volume. Throughout my Notes and Introduction I have had two objects in view—one to execute as complete an edition as possible of my author, the other to produce a work of educational value to the student of philosophy, or, generally, of the history of thought and science. Where these two objects have at all interfered with each other, instead of sacrificing one, I have endeavoured to combine both. Thus, the frequent references to Bacon's other writings, and what I may call the

antiquarian portions of the work, would hardly have been necessary for merely educational purposes. On the other hand, if I could always have relied on the co-operation of a mature student, some of the references and many, perhaps, of the explanations might have been spared. But, as a rule, I think, the results aimed at by the two objects have pretty nearly coincided, and I have thought it, at least, safer to err on the side of offering too much elucidation rather than too little.

The position of Bacon mid-way, as it were, between Scholasticism, on one side, and Modern Philosophy and Science, on the other, is so interesting that I cannot but think that much has even still to be learnt from the study of his works, and especially of this, the chief and most influential of them all. Not only is the Novum Organum a collection of fine sayings and suggestive remarks, but a knowledge of it is indispensable to the student of the History either of Logic, of Philosophy, or of the Physical Sciences. Moreover, it furnishes an excellent starting-point in the history of any of these subjects, whether we wish to go backwards or forwards. But this very fact renders it essential that it should be accompanied with a copious commentary, both to point out the objects of interest, and to institute comparisons with what the reader has seen or will see elsewhere. Nor is the interest of the work simply historical. As I have pointed out in the section of the Introduction devoted to that subject, its present value to the student of philosophy or logic is also, I believe, by no means inconsiderable.

That many of Bacon's individual maxims and doctrines may be found in other authors of the period I am fully aware, and have not failed elsewhere to notice; but there is no other writer who brings together his stores in such rich abundance, who clothes his sentiments in such felicitous language, or who, I believe, is so truly representative of the hopes and aspirations, of the thoughts and tendencies of that remarkable time.

Those subjects which could not conveniently be treated within the compass of notes, and were still of too much importance to be omitted, I have discussed at some length in the Introduction. In the preliminary remarks to this portion of my work, I have stated my reasons for writing in detached sections rather than for offering a general appreciation of Bacon's doctrines and position.

I have only annotated the Novum Organum itself, though I have thought it would be interesting to print the preliminary pieces which appeared with it on its first publication. The text of these, as well as of the work itself, is re-produced after the First Edition, with the exception of several alterations in the punctuation and the frequent substitution of small for capital letters. The annotation of the minor pieces would merely have resulted in much useless repetition.

The Index to the Text is based on Mr. Kitchin's (as that also is based on the Index appended to the

Oxford Edition of 1813), though I have introduced many alterations and additions. With the Index to the Text is incorporated the Index to the Notes. This is, for the most part, in English, as the other is, for the most part, in Latin. The admixture of English and Latin in the same Index presents, it must be confessed, a somewhat motley appearance, but I trust that this defect will be more than outweighed by the facility for reference which is afforded by such an arrangement. When a word occurs in the Notes only, it is printed in Italics; when it occurs in the Text only, or both in the Text and the Notes, it is printed in the ordinary Roman type.

I have thought it desirable to draw up a separate Index to the Introduction; this includes some references to the additional matter, appended to the Preface.

It only remains to express my obligations to previous writers on the same subject, and to the friends who have assisted me in my work. I have read, or, at least, consulted all the annotated editions of the Novum Organum and all the dissertations on Bacon's Logic or Philosophy, to which I have been able to obtain access. To these I have, wherever there was occasion, expressed my obligations, but I must here specially select, for more particular acknowledgment, the magnificent Edition of Bacon's Works by Ellis and Spedding, the French Edition by M. Bouillet, the Edition of the Novum Organum by Mr. Kitchin (whose generosity in allowing me to replace it by the present edition demands my

special thanks), the works on Bacon's Philosophy by De Rémusat and Kuno Fischer, Mr. Macvey Napier's Essay on Bacon, and Professor Playfair's Preliminary Dissertation in the Encyclopædia Britannica. With reference to previous writers generally, I may here take occasion to remark that, where any explanation, reference, authority, &c., mentioned by them, had previously occurred to me or would certainly have occurred to me in the course of composition, I have not thought it necessary to make any special acknowledgment, or to adopt inverted commas, but, where this has not been the case, I believe I have almost invariably done so. The question of literary property is always a difficult one, but I have certainly not consciously or deliberately appropriated what is not my own.

I have to thank Mr. Spedding for the uniform courtesy with which he has answered any questions relative to the literary department of my work, Professors Rolleston and Clifton, who have occasionally supplemented my own somewhat defective knowledge of scientific facts, my colleagues, Mr. W. Warde Fowler and Mr. N. Bodington, Fellows of Lincoln College, who have given me much valuable assistance in revising the proofs and suggesting corrections, as the work proceeded, as well as Mr. J. A. Stewart, late Senior Student of Ch. Ch., and Mr. J. Cotter Morison, who have performed the same service for me with regard to detached portions of the book. But my thanks are especially due to Professor H. J. S. Smith, who, notwithstanding his numerous engagements, has kindly revised my proofs, and

frequently given me the benefit of his very valuable advice and assistance. Had his other pursuits admitted of it, I know of no one who, from his varied accomplishments, was better fitted to undertake the task of editing the Novum Organum than Professor Smith himself.

LINCOLN COLLEGE,
Feb. 4, 1878.

ADDITIONS AND CORRECTIONS.

In a work like the present, touching on so many and such various topics, it is unavoidable that additions and corrections should occur to the Author, after the sheets have passed through the Press. Some of these I append in the present place. Many others will probably occur to my readers, but they will, I trust, be inclined to treat with indulgence any errors or omissions in a work which has attempted to deal, and has been compelled to deal, with questions extending over so wide a field—a field comprising philosophy, logic, literature, science, and the history of all these subjects—with some departments of which almost any writer must necessarily have but a superficial acquaintance.

On p. 36 of the Introduction, I have, perhaps, spoken too strongly, and without sufficient qualification, of the tenacity with which the Cambridge mathematicians clung to the Cartesian system after the publication of Newton's discoveries. Any way, had I been acquainted with Dr. Whewell's letter in the Museum Criticum, vol. ii. pp. 514–9 (for a knowledge of which I am indebted to Mr. C. Wordsworth's Scholae Academicae, p. 67), I should not have adopted so unreservedly the authority of Professor Playfair in my note. Had I stated that many of the mathematical teachers at Cambridge continued to teach the Cartesian system for some time after the publication of Newton's Principia, I believe that I should have confined myself within the limits of accuracy.

In speaking of the superstitious fancies of Bacon's age (Introduction, p. 30), I might, had it not escaped my memory at the time, have given a most apposite reference to Mr. Pattison's Casaubon, pp. 497–500, a passage which will illustrate the interest at that time attaching to stories of the

marvellous, as well as the fanciful views of nature which then prevailed.

The section of my Introduction which treats of Bacon's Influence on Philosophy and Science should have contained some notice of the testimony of Barrow, an account of which will be found in Whewell's Philosophy of Discovery, pp. 177–9. This author, writing in 1652, had evidently, as Dr. Whewell says, 'read the Novum Organum in a careful and intelligent manner, and presumed his Cambridge hearers to be acquainted with the work.'

In this section (p. 108), I have referred, following Mr. Macvey Napier, to Comenius (b. in Moravia 1592, d. 1671, many of whose works were published at Leszno in Poland), as having in his Physicae Synopsis spoken in laudatory terms of Bacon. But I was not aware, till Mr. Pattison directed my attention to the fact, that the educational works of Comenius are so full of allusions to Bacon, or that the thoughts and modes of expression of this writer are so Baconian in character as I find to be the case. If any reader cares to pursue this subject, he will find an excellent example of what I mean in the Pansophici Libri Delineatio (occupying pp. 403–456 of the first Part of the Opera Didactica, published at Amsterdam, in 1657). Speaking of rules for distinguishing the true from the false, Comenius says: 'Atque talem normam in natura scrutanda reperisse visus est Illustrissimus Verulamius, artificiosam quandam inductionem, quae revera in naturae abdita penetrandi reclusa via est. Verum enimvero, quia haec plurium hominum et seculorum continuatam industriam poscit, atque adeo tum operosa, tum a successu quasi incerto suspensa videtur, fit, ut praeclarum inventum a plerisque tanquam inutile contemnatur.' In a previous passage, he asks: 'Non est nihil, quod Verulamius mirabili suo organo rerum naturas intime scrutandi modum infallibilem detexit?' This work was published at Oxford in the year 1637, under the title of Conatuum Comenianorum Praeludia.

In the Preface to the Physicae ad Lumen Divinum Reformatae Synopsis, Amst. 1643, referred to in my Introduction, he speaks of the Instauratio Magna as 'opus

suspiciendum et quod ego non aliter quam lucidissimum exorientis novi saeculi Phosphorum intueri soleo.'

But what is more remarkable than individual passages is the general influence of Bacon's writings on the tone and thoughts of this author.

In note 6 on p. 231, I have inadvertently spoken of the 'primum mobile' as the 'outermost sphere of the Universe,' whereas I should have said that it is the first or outermost of the 'moveable spheres,' these being distinguished from the fixed sphere, or empyrean heaven, which was supposed to be illimitable in extent, and to encircle all the others.

It has been pointed out to me by my relative, Mr. James Fowler of Wakefield, that in the work of Athanasius Kircher, Magnes sive De Arte Magnetica (first published at Rome in 1641), there is a list of 'Axiomata seu Pronuntiata De Natura et Arte,' in which the maxims 'Homo naturae minister et Interpres tantum facit, quantum e naturae ordine re vel mente observarit' (I. 1), 'Natura non nisi parendo vincitur; vincitur autem cum,' &c. (I. 3), 'Ad opera externa nihil aliud potest homo, quam ut corpora naturalia admoveat, et amoveat, natura intus transigente' (I. 4), and 'qui formas rerum novit, is unitatem in materiis dissimillimis complectitur' (II. 3), are referred respectively to Pythagoras, Synesius, Maimonides, and Averroes. The last of these maxims is likely enough to be a common-place, and I have made no effort to verify the quotation, but I have searched in vain for the three former. The first is certainly not included in any of the sayings attributed to Pythagoras or the Pythagoreans, with which I am acquainted. From the fact that Kircher (who was a Jesuit, and published his work at Rome) gives these maxims in almost the very words and the very sequence of words of Bacon, and, moreover, arranges them in the very order in which they occur in the Novum Organum, I am inclined to suspect that he did some violence to the passages he had in mind, in order to throw discredit on the English philosopher.

CONTENTS.

BACON'S NOVUM ORGANUM. Ed. Fowler.

FURTHER ADDITIONS AND CORRECTIONS.

Page 4, line 13. *For* 'Pardon' *read* Limited Pardon

„ *Between lines* 4 *and* 5 *from the bottom of the page, insert*

Publication of the Second Edition of the Resuscitatio, containing additional matter . . . . 1661.

Publication, after Rawley's death, of the Third Edition of the Resuscitatio, also containing new matter . . . . . . 1671.

P. 7, l. 17. *After the words* 'the one' *insert* (if we except the sixth, which was to be the crown of the whole, and the gradual work of posterity)

P. 9, l. 2. *For* 'or' *read* a

P. 11, l. 9. *Erase* 'those'

P. 13, ll. 24, 25. *For* 'that work,' &c., *substitute* the De Augmentis into English by Dr. Gilbert Wats.

P. 24, note 45. *For* 'Poeta' *read* Porta

P. 27, l. 29. *After* 'error' *insert* if such it be, *and add as a note,* See p. 338, n. 6.

P. 28, l. 3, &c. *For* 'It is' *substitute* It appears at first sight *Erase the words* to personal jealousy *At end of paragraph add* The probability is that, like most of Harvey's contemporaries, he regarded the theory as hardly worthy of serious discussion. Aubrey (Lives, Vol. ii, p. 383) tells us he had heard Harvey say that, 'after his booke of the Circulation of the Blood came out [in 1628], he fell mightily in his practice, and 'twas believed by the vulgar that he was crack-brained; and all the physitians were against his opinion, and envyed him.'

P. 36, l. 27. *After* 'Dilettante' *add* (or, to speak more correctly an Amateur)

P. 37. *For* 'Dilettante' *read* Amateur

P. 43, n. 15. *For* 'De Vanzelles' *read* De Vauzelles *For* 'It is' *read* It was

P. 45, n. 18. *For* 'pp. 130, 131.' *read* pp. 129-131.

P. 49, l. 3. *For* 'have' *read* detect

P. 58, l. 11. *For* 'put this law in action' *read* further the development of the conditions,

P. 86, l. 32. *Erase the words* 'Inductio per Enumerationem Simplicem or'

„ l. 35. *To word* 'practice' *append the following note,* He does not always insist on it, even theoretically. See An. Post. I. 31, p. 88 a 4, 5; Top. VIII. 8, p. 160, b, 3.

P. 87, n. 95, last paragraph. *Erase the words* 'answering to the analogy of Mr. Mill and recent logicians.'

[TURN OVER.

FURTHER ADDITIONS AND CORRECTIONS.

P. 108, l. 5. *After* 'German' *insert* and Dutch
„ l. 14. *For* 'Commenius' *read* Comenius
P. 129, l. 1. *Before* 'independent' *read* cautious and
P. 144, l. 9. *Erase* 'Mr. Headlam's' *and substitute* that contained *After* 'Edition,' *insert* in
P. 148, l. 13. *For* 'De Vanzelles' *read* De Vauzelles
„ l. 21. *Before* 'De Maistre' *insert* Joseph
P. 187, n. 1, l. 4. *Add* Mr. Bywater has pointed out to me a passage in Galen (Ed. Kühn. tom. xv. p. 309) shewing that the expression 'minister naturae' was used by Hippocrates, who called the true physician τῆς φύσεως ὑπηρέτην.
P. 190, n. 7, second paragraph, l. 11. *Insert after* (1005 a. 19–21) *the words* Cp. Post. An. I. 10.
P. 201, l. 24. *For* 'abstraced' *read* abstracted.
P. 235, notes 13, 14. *For* 'minime generalia' *throughout, substitute* infima.
P. 263, n. 3. *After* 'Mr. Spedding' *insert* (quoting a note by Mr. Ellis to Temporis Partus Masculus, E. and S., vol. iii, p. 531)
P. 277, l. 20. *For* 'finis' *read* fines
P. 278, l. 6. *Erase comma after* 'consensus'
P. 303, n. 1. *After* 'Example' *insert* (παραδεῖγμα) *After* 'Aristotle' *erase the words* 'or the Analogy of Modern Logic.'
P. 309, n. 17. *Erase the words* 'either to John Lorenzo Koster of Haarlem or'
P. 355, n. 61, fourth paragraph, in lines 2, 3, *substitute* and *for* 'or' In line 5, *for* 'would' *substitute* the conditions would thus
P. 362, n. 83, l. 13. *For* 'Melloir' *substitute* Melloni
P. 372. *Omit* note 20.
P. 379. *Omit* note 42.
P. 406, n. 27, l. 13. *Erase comma after* 'causation'
P. 409, n. 36. *For* 'Caryophilli' *read* Caryophylli
P. 450, n. 49. *At end of note add* after which the cup is again applied, for the purpose of drawing out the blood.
P. 456, n. 69. *For* 'gases' *read* substances
P. 458, n. 70. *For* 'an' *read* on
P. 498, n. 76. *For* 'Averrois' *read* Averroes
P. 547, n. 40. *After* 'Mr. Spedding' *read* (following Mr. Ellis's notes)
P. 558, n. 70. *For* 'Tartalea' *read* Tartaglia.
P. 594. *For* 'Commenius' *read* Comenius
P. 598. *For* 'Vanzelles' *read* Vauzelles
P. 601. *For* 'Axiomata minime generalia,' *read* Axiomata infima, *and, in the same line as well as under the headings* 'Axiomata generalissima,' *and* 'Axiomata media,' *for* 300 *read* 301.
Add Axiomatum scala ascensoria et descensoria, 407.

INTRODUCTION.

In the various sections of this Introduction, which will be of the nature of what are commonly called Prolegomena, I propose to discuss a number of questions which, either from their importance or from want of space, I have found it inconvenient to treat in the notes. Many of these have been selected for me, by the circumstance that they have been the points on which the controversies in respect to Bacon's writings or philosophy have mainly turned. It was impossible to pass them over in silence, and some of them seemed to demand a fuller treatment than they had hitherto received. Hence the length of several of the sections, such as those on Bacon's Influence, the Anticipations of his teaching, &c. Other questions have been selected by me more spontaneously, on account of their importance to a due understanding of Bacon's position as a reformer of logic and science. Such are those on the present value of Bacon's writings, on his general philosophical opinions, on the meaning he attaches to the word 'Form,' on his method of Exclusions, &c. But, with reference to all the sections alike, I must warn the reader that I have studied thoroughness of treatment even at the expense of occasional prolixity. A general sketch of Bacon's philosophy and a general appreciation of its merits and its relation to other systems is to be found in almost every History of Philosophy, and I have not thought it desirable to add to the number of such accounts already existing. But it has appeared to me that a more complete treatment than is usual of special questions, mainly connected with the Novum Organum or its history, might be not only a real contribution to the large amount of literature we already possess on the subject, but also the best introduction to the intelligent study of this edition. In adopting

this course, I have assumed in my readers a certain amount of acquaintance with the history of philosophical speculation, as well as with the outlines of logic. But to readers, who do not come to the study of the book with this amount of acquirement, I cannot think that an edition, worth the putting out, could be of any service.

The arrangement of the Sections has been a matter of some difficulty, as several of them stand in little relation to those that precede or follow. On the whole, I have thought it most convenient, keeping apart as far as possible the expository sections from those which are mainly historical, and bringing together those which stand in any close connection, to adopt the following order:

§ 1. Dates of the leading events in Bacon's Life, and of the first publication of his principal writings.

§ 2. The object of the Novum Organum.

§ 3. Relation of the Novum Organum to the more important of Bacon's other philosophical works.

§ 4. Was the Novum Organum written in Latin?

§ 5. Bacon's general philosophical opinions.

§ 6. Bacon's scientific attainments and opinions, with special reference to the state of knowledge in his time.

§ 7. Bacon's religious opinions.

§ 8. The meaning attached by Bacon to the word 'Form' (including a note on the 'Four Causes' of Aristotle).

§ 9. Bacon's method of Exclusions.

§ 10. Bacon's rejection of Final Causes in Physics.

§ 11. The causes of Aristotle's failure in his physical researches.

§ 12. The reaction against the authority of Aristotle.

§ 13. Anticipations of Bacon's Method and Teaching.

§ 14. Bacon's Influence on Philosophy and Science, including the Testimonies of early writers to him.

§ 15. Present Value of Bacon's Logical Works.

§ 16. Opponents of Bacon.

§ 17. Bibliography of the Novum Organum.

*** Short summaries of the contents of Books I and II are prefixed to those Books respectively.

§ 1. DATES OF THE LEADING EVENTS IN BACON'S LIFE, AND OF THE FIRST PUBLICATION OF HIS PRINCIPAL WRITINGS.

Born at York House	Jan. 22, 1560–1.
Entered at Trinity College, Cambridge .	April, 1573.
Admitted 'de societate magistrorum' at Gray's Inn	June 27, 1575.
Accompanies Sir Amias Paulet to Paris .	Sept. 25, 1576.
Returns to England	March 20, 1578–9.
Admitted Utter Barrister of Gray's Inn .	June 27, 1582.
First essay on the Instauration of Philosophy, which he called *Temporis Partus Maximus*, composed, about	1583.
Begins public life. Takes his seat as Member for Melcombe in Dorsetshire . . .	Nov. 23, 1584.
Becomes a Bencher of Gray's Inn . .	1586.
Acquaintance with Essex begins, about .	1591.
Edition of the Essays in their earliest shape	1597.
Arraignment of Essex	Feb. 1600–1.
'Declaration of the Practices and Treasons attempted and committed by Robert late Earl of Essex'	1601.
Death of Elisabeth and Accession of James	March 24, 1602–3.
Publication of the Advancement of Learning	Oct. 1605.
Gunpowder Plot	Nov. 5, 1605.
Marriage to Alice Barnham . . .	May 10, 1606.
Appointed Solicitor General . . .	June 25, 1607.

['It was probably about this time that Bacon finally settled the plan of his "Great Instauration," and began to call it by that name.' Spedding's Letters and Life, vol. iii. p. 363.]

Composition of the Cogitata et Visa . .	Summer of 1607.
Composition of the Novum Organum probably begun	1608.
An instalment of the Instauratio Magna (probably the Redargutio Philosophiarum) sent to Toby Matthew	Oct. 10, 1609.
Publication of De Sapientia Veterum .	End of 1609.
Publication of the Essays in their second form	Oct. 12, 1612.
Appointed Attorney General . . .	Oct. 28, 1613.
Returned Member for Cambridge University	April 2, 1614.

Peacham's case	1614–15.
Admitted Privy-Councillor	June 9, 1616.
Appointed Lord Keeper	March 7, 1616–17.
Appointed Lord Chancellor	Jan. 4, 1617–18.
Created Baron Verulam	July 12, 1618.
Execution of Raleigh	Oct. 29, 1618.
Publication of the Novum Organum	Oct. 12, 1620.
Created Viscount St. Alban's	Jan. 27, 1620–1.
Meeting of Parliament	Jan. 30, 1620–1.
Sentence of the House of Lords	May 3, 1621.
Retires to Gorhambury	June 23, 1621.
Pardon sealed by the King, probably in	Nov. 1621.
Publication of the History of Henry VII	End of March, 1622.
Publication of the first monthly instalment of the Natural and Experimental History—Historia Ventorum	November, 1622.
Publication of another instalment—Historia Vitae et Mortis	Jan. 1622–3.
Publication of the De Augmentis	Oct. 1623.
Death of James I	March 27, 1625.
Publication of the third Edition of the Essays, much enlarged	1625.
Death	April 9 (Easter Sunday), 1626.

Publication of the Sylva Sylvarum and New Atlantis, by Rawley	1627.
Publication of 'Certaine Miscellany Works' by Rawley	1629.
Publication of the Opera Moralia et Civilia by Rawley	1638.
Publication of the Remains	1648.
Publication of Isaac Gruter's Collection	1653.
Publication of the Resuscitatio by Rawley	1657.
Publication of the Opuscula varia posthuma by Rawley	1658.
Publication of Baconiana by Tenison	1679.
Publication of Letters and Remains by Stephens	1702.
„ „ (Second Collection)	1734.
Publication of Letters, Speeches, &c. by Birch	1763–4.

§ 2. ON THE OBJECT OF THE NOVUM ORGANUM.

The object of the Novum Organum, and of Bacon's philosophy in general, is, stated summarily, to enlarge the dominion of man, 'Regnum Hominis' as he phrases it, by increasing his knowledge of Nature and his power over her operations. This end can only be accomplished, he conceives, by freeing the mind from its false prejudices, especially its habit of blind submission to authority, and thus bringing it face to face with the facts of Nature. But these facts are themselves of little use, unless sifted, compared, and employed as stepping-stones to generalisations from which other facts can be legitimately deduced. Hence, the need of a new method of Induction, which shall not merely accumulate but select instances on certain rational principles, draw legitimate inferences from them, and thus guarantee the truth of those first principles from which our deductive reasoning proceeds. This more scientific form of Induction it is more especially the aim of the Novum Organum to supply, but, previously to laying down any rules for it or exemplifying its employment, it is necessary to insist on its importance, to free the mind from those obstacles which might prevent it from having recourse to this assistance, to point out the sources of our errors in the past, and to shew what hopes may be conceived of the future. The preliminary task is undertaken in Book I. The formal exposition of the method begins in Book II, but the work, as left by Bacon, is not completed.

This brief summary may be useful to the student, and, therefore, I place it at the head of the Introduction. But it appears to me undesirable to expand it, as, otherwise, I should be anticipating the words of my author as well as rendering necessary several explanations which would now needlessly delay and weary the reader, but which I shall offer from time to time, in their proper place, as the work proceeds.

§ 3. RELATION OF THE NOVUM ORGANUM TO THE MORE IMPORTANT OF BACON'S OTHER PHILOSOPHICAL WORKS.

In his letter to Father Fulgentio, which Mr. Spedding refers to 1625[1], Bacon says: 'Equidem memini me, quadraginta abhinc annis, juvenile opusculum circa has res confecisse, quod magna prorsus fiducia et magnifico titulo "Temporis Partum Maximum" inscripsi.' This would shew that, at or about the early age of twenty-five, Bacon had already begun to contemplate the Renovation of Science. But the first form in which this idea occurred to him seems to have been to write a great work on the Interpretation of Nature, that is, on the new method of Induction[2]. Of this, we have some fragments in Valerius Terminus, the whole or the greater part of which seems to have been written about 1603 or 1604[3]. It is needless to add that Bacon's idea was afterwards far more fully carried out, in part at least, by the Novum Organum. Of the much more extended scheme of the Great Instauration in six parts, we have the first intimation[4] in the Partis Instaurationis Secundae Delineatio et Argumentum, which Mr. Spedding thinks 'may be referred with tolerable confidence to the year 1606 or 1607[5],' and certainly to some time prior to the composition of the Cogitata et Visa, which, in its first form, seems to have been composed in the summer or autumn of 1607[6]. Both these works are interesting as covering much of the same ground as the Novum Organum, and may profitably be compared with it and with one another.

Of the Great Instauration, no part, as Mr. Ellis truly says, can be regarded as absolutely complete, though the first part, the Partitiones Scientiarum, pointing out what had been done and what remained to be done in the various sciences, is more adequately represented than any other. This is contained in the De Augmentis, published in 1623 (about three years after the publication of the

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[1] Spedding's Letters and Life, vol. vii. pp. 530–533.

[2] Ellis and Spedding's Edition of Bacon's Works, vol. i. pp. 82, 83.

[3] See a discussion on the date of this work by Mr. Spedding, E. and S., vol. iii. pp. 206–213.

[4] But it does not follow that Bacon had not long before formed the design. See Mr. Spedding's remarks on this subject, vol. i. pp. 103–106. The *name* Instauratio, he tells us, does not occur in any of Bacon's letters till 1609 (p. 107).

[5] Vol. iii. p. 544.

[6] See E. and S., vol. iii. p. 589; Spedding's Letters and Life, vol. iii. pp. 365, 366. The Cogitata et Visa seems to have undergone much subsequent correction.

Novum Organum), and founded on a previous work, written in English and published in 1605, entitled, Of the Proficience and Advancement of Learning. When the latter work was written, Bacon had probably not yet matured his conception of the Great Instauration. There is a fragment of a work on the same subject, intermediate in date between these two, first published by Gruter in 1653, entitled Descriptio Globi Intellectualis. This tract, which may be referred to about the year 1612, was designed on a larger scale than either of the two already referred to. The part worked out is mainly on Astronomy, and appended to it is another tract, entitled Thema Coeli, giving a provisional account of Bacon's own astronomical views, and evidently forming part of the same work. Portions of the tract entitled Valerius Terminus, referred to in the last paragraph, also go over the same ground as the Advancement and the De Augmentis.

The second part of the Great Instauration, or the proper method of interpreting Nature, was evidently the one to which Bacon attached the greatest importance. It is mainly represented by the Novum Organum, though preliminary drafts of portions of this work are to be found in parts of the Valerius Terminus, and in the Partis Secundae Delineatio, the Cogitata et Visa, the Temporis Partus Masculus, and the Filum Labyrinthi sive Inquisitio Legitima de Motu, to say nothing of smaller pieces, such as De Interpretatione Naturae Sententiae Duodecim, &c. The scheme of the Valerius Terminus does not appear to extend beyond the first and second parts of the Great Instauration, and another peculiarity is that what in the Novum Organum is called the investigation of the form is there (ch. 11) called the freeing of a direction. In the Partis Secundae Delineatio we have, as already noticed, the first intimation of the six parts of the Great Instauration, but neither there nor in Valerius Terminus does the idea yet seem to have occurred to Bacon of setting forth his meaning mainly by means of an example. This plan is announced at the end of the Cogitata et Visa[7], and is worked out in the second book of the Novum Organum. On the other hand,

[7] 'Atque diu et acriter rem cogitanti et perpendenti, ante omnia visum est ei, Tabulas Inveniendi, sive legitimae Inquisitionis formulas in aliquibus subjectis, proponi tanquam ad exemplum, et operis descriptionem fere visibilem.' E. and S., vol. iii. p. 619. The example first selected by Bacon was Motion. See the Filum Labyrinthi, sive Inquisitio Legitima de Motu, printed by Ellis and Spedding in vol. iii. p. 621, &c. This piece is followed in Ellis and Spedding's Edition by a rough and imperfect draught of an enquiry on Heat and Cold, written probably in 1608.

in the Partis Secundae Delineatio, as Mr. Spedding remarks in his Preface to that work (vol. iii. p. 544), 'the description of the *Ministratio ad Rationem* adds something to what we otherwise know concerning those parts of the inductive process which were to have been developed in the third book of the Novum Organum.' Appended to the Delineatio in Ellis and Spedding's Edition is a tract called Redargutio Philosophiarum[8], which, says Mr. Spedding, 'may be considered as the first chapter of the second part of the Instauratio, as it was then designed.' It consists, as its name implies, of an attack upon preceding systems of philosophy, and, though designed to be part of the work of which the Delineatio is the sketch, was probably not composed till some time afterwards[9]. Closely resembling the Redargutio, but far more arrogant in its tone, is the extant portion of another work entitled Temporis Partus Masculus, sive De Interpretatione Naturae Libri Tres. Of this the first and second chapters only exist, the second, as Mr. Spedding thinks, written at a considerable interval after the first, though before the Redargutio. This second chapter goes over the same ground as the Redargutio and the aphorisms on the Idola Theatri in the Novum Organum, but is written in a peculiarly arrogant, not to say, insolent tone. Mr. Spedding conjectures, I think rightly, that this arrogance and exaggeration are to be explained on the supposition that Bacon was making an experiment in the art of commanding attention and winning disciples[10]. If he spoke loud enough, and used sufficiently strong language, he thought he might compel men to listen to him. To me the whole performance seems to have a strained and almost theatrical character.

The composition of the Novum Organum (as I have shown in the

[8] In Isaac Gruter's Edition, only a small portion of the Redargutio (namely to the words 'in chorum receptis,' E. and S., vol. iii. p. 561) follows the Delineatio. But in the Appendix to Mallet's Life of Bacon (1760), the same tract, with the title, beginning at the words 'Dum haec tractarem' (E. and S., p. 558), is printed for the first time from the Harleian MSS. Thus, the two copies over-lap, and Mr. Spedding has restored the tract by piecing them together.

[9] See Mr. Spedding's Preface, vol. iii. pp. 544–546.

[10] In the Preface to the Delineatio (p. 545), Mr. Spedding quotes, amongst others, the two following entries from Bacon's Diary (the Commentarius Solutus), dated July 26, 1608:

'Discoursing scornfully of the philosophy of the Grecians, with some better respect to the Ægyptians, Persians, Caldees, and the utmost antiquity, and the mysteries of the poets.'

'Comparing the case with that which Livy sayeth of Alexander, Nil aliud quam bene ausus vana contemnere.'

section on its Bibliography) appears to have been commenced about 1608. When the first edition appeared in 1620, it was preceded by the piece beginning, 'Franciscus de Verulamio sic cogitavit,' or Dedication to the King, a Preface to the Instauratio Magna (of which, though only the second part, it was the first instalment), the Distributio Operis (that is, the plan of the whole Instauration), and a Preface peculiar to itself. It was followed by a small tract, entitled Parasceue ad Historiam Naturalem et Experimentalem, printed, by anticipation, as a sort of specimen or, possibly, résumé of the penultimate part of the Novum Organum, promised in ii. 21. Finally the volume is closed by a Catalogus Historiarum Particularium Secundum Capita, or list of desiderata in the specific materials for induction.

The Novum Organum, I need hardly remark, is only a fragment of the much larger work which Bacon contemplated under that title, as adequately representing the second part of the Great Instauration. The enumeration of the parts wanting will be found in Book ii. Aph. 21, and, again, though less distinctly, in Aph. 52. Nevertheless, though only a fragment, the Novum Organum, and especially the first Book, is the most carefully written of all Bacon's philosophical works. According to Rawley[11], it was written out twelve several times, and we have just seen by what a number of essays the final effort was preceded. Moreover, as describing the new method of which the renovation of knowledge was to be the result, it was the keystone of Bacon's entire system.

The Third Part of the Great Instauration is designated Phaenomena Universi, sive Historia Naturalis et Experimentalis ad condendam Philosophiam, and was to contain a collection of arranged and sifted materials on which the method of induction was to work. Of this part, even according to Bacon's limited conception of the extent and variety of nature, we have only a very small portion, and, according to a juster estimate of the boundless extent of the 'Phaenomena Universi,' that portion might almost be described as infinitesimal. Such as it is, however, it is contained mainly in the Historia Ventorum, the Historia Vitae et Mortis, the Historia Densi et Rari, the Sylva Sylvarum, and the New Atlantis. In the year 1622 Bacon published a small volume entitled Historia Naturalis, &c., quae est Instaurationis Magnae Pars Tertia. In the beginning of

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[11] See the Life prefixed to the Opuscula as well as that prefixed to the Resuscitatio.

the Dedication, he thus describes his design and the character of the present instalment: 'Primitias Historiae nostrae Naturalis Celsitudini tuae humillime offero. Rem mole perpusillam, veluti Granum Sinapis: sed tamen pignus eorum, quae Deo volente sequentur. Obstrinximus enim nos ipsos tanquam voto, singulis nos mensibus, ad quos Dei bonitas (cujus agitur Gloria tanquam in cantico novo) vitam nostram produxerit, unam, aut plures ejus partes, prout fuerint magis aut minus arduae, aut copiosae, confecturos, et edituros. Moti etiam fortasse erunt alii, nostro exemplo, ad similem industriam: praesertim postquam penitus perspexerint, quid agatur. Nam in Historia Naturali bona, et bene instituta, clavis sunt et Scientiarum et Operum.' This volume contains only general prefatory remarks, the Historia Ventorum, and an Aditus to each of the following proposed treatises: Historia Densi et Rari; Historia Gravis et Levis; Historia Sympathiae et Antipathiae Rerum; Historia Sulphuris, Mercurii, et Salis; and Historia Vitae et Mortis. These five 'Historiae' were to follow the Historia Ventorum at intervals of a month. It appears that the volume containing the Historia Ventorum was published about the beginning of November, 1622; the Historia Vitae et Mortis about the end of the following January, 1622–3[12]. The reason for bringing out the latter book before the four intermediate ones is stated to be 'propter eximiam rei utilitatem; in qua vel minima temporis jactura pro pretiosa haberi debet.' The Historia Densi et Rari did not appear till the publication of Dr. Rawley's Opuscula Varia Posthuma in 1658. It goes over a good deal of the same ground as a tract, entitled Phaenomena Universa, published by Gruter in 1653[13]. The remaining three subjects Bacon does not appear to have handled, at least in separate treatises.

The Sylva Sylvarum, which is a miscellaneous collection of observations and experiments, taken mainly from books, was not published till after Bacon's death. It was edited by Rawley in 1627, Bacon having died in 1626. Interesting in many respects as this collection is, it is the least creditable of Bacon's philosophical works, and has furnished Liebig and other antagonists with many of their most effective weapons. In fact, as Bacon is reported by Rawley to have said himself, 'if he should have served the glory of his own Name, he had been better not to have published this Natural History.' In my

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[12] See a note by Mr. Spedding, E. and S., vol. ii. p. 3.

[13] On the relation between these two works, see a note by Mr. Spedding, vol. ii. p. 229.

remarks on Liebig, under the section headed 'Opponents of Bacon,' I have spoken at greater length on this subject.

Appended to the Sylva Sylvarum in Rawley's Edition is the New Atlantis, a work also then for the first time published. This is deservedly one of the most popular of Bacon's works; it bears the stamp of his genius as much, perhaps, as anything which he wrote; and, lastly, it is credited, and I conceive justly so, with having, to a large extent, suggested the foundation and programme of our own Royal Society, if not those of several foreign scientific associations as well. Its relation to the Sylva Sylvarum cannot be better described than in the language of Mr. Spedding:—'The New Atlantis seems to have been written in 1624, and, though not finished, to have been intended for publication as it stands. It was published accordingly by Dr. Rawley in 1627, at the end of the volume containing the Sylva Sylvarum; for which place Bacon had himself designed it, the subjects of the two being so near akin; the one representing his idea of what should be the end of the work which in the other he supposed himself to be beginning. For the story of Solomon's House is nothing more than a vision of the practical results which he anticipated from the study of natural history diligently and systematically carried on through successive generations [14].'

Amongst the 'Impetus Philosophici' which occupy the latter part of Gruter's volume are two small pieces entitled Scala Intellectus sive Filum Labyrinthi and Prodromi sive Anticipationes Philosophiae Secundae. These were intended as Prefaces to the fourth and fifth parts of the Instauratio respectively. Whether anything more relating to these parts is extant seems open to doubt. Possibly the Inquisitio Legitima de Motu sive Filum Labyrinthi may be an 'exemplar' belonging to the fourth part, but Mr. Spedding inclines to think that it was designed originally as the example of method for the second part of the Instauration, and subsequently abandoned for the Inquisitio de Forma Calidi. As respects the fifth part, however, Mr. Spedding seems disposed to admit to a place among the Prodromi the treatises entitled De Fluxu et Refluxu Maris, De Principiis atque Originibus, Cogitationes de Natura Rerum, and Thema Coeli, of which last we have already spoken in connection with the Descriptio Globi Intellectualis.

To the sixth part of the Great Instauration, namely Philosophia Secunda, sive Scientia Activa, which, in its full extent, was to be the

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[14] E. and S., vol. iii. p. 121.

work of posterity, Bacon hoped himself to supply 'initia non contemnenda.' For any special treatise, however, which can be referred to this head, we search in vain amongst his works. Nor is this fact without its explanation. The Scientia Activa was to depend on the knowledge of 'Forms,' but how far Bacon was from having attained to a knowledge of 'Forms,' and how vague was the conception which he often attached to this term, will be only too familiar to the attentive student of the Novum Organum. The story which he applies to the Alchemists [15] of the old man who bequeathed to his sons a piece of gold hidden in a vineyard applies also, in no small measure, to himself. He did not discover 'Forms,' but he did what was of far more value to posterity; he recalled men to the observation of facts, gave an impulse to the study of nature, and, if not the founder of the Inductive Method, at least contributed more than any other man to its wider, more correct, and more fruitful employment.

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§ 4. WAS THE NOVUM ORGANUM WRITTEN IN LATIN?

In one of his articles in the Allgemeine Zeitung (Nov. 3, 1863), Liebig asserts roundly that Bacon wrote none of his works in Latin; that they were translated by people who knew nothing of the subjects of which they treated, and, as Bacon was not very clear upon them himself, we may imagine the result! In another article (March 6, 1864), he is especially angry with Sigwart for having called in question this assertion, and reiterates dogmatically the statement that *all* the Latin works of Bacon required the intervention of a translator. The proof is a letter from Bacon to Dr. Playfer of Cambridge (given in Spedding's Life and Letters, vol. iii. pp. 300, 301), requesting him to undertake the translation of the Advancement of Learning. Liebig argues that, if, at the age of forty-six (he should have said *about* the age of forty-six or forty-seven; for there is nothing enabling us to fix the *exact* date of this letter), and when he had but few engagements, Bacon did not recognise his aptitude for translating his first scientific work into Latin, it is hardly likely that he would possess this aptitude in his sixtieth year, when he held high office under the Crown, and was immersed in business. Now, there is nothing whatever in Bacon's letter to Playfer which either asserts or implies inaptitude to write Latin. And, as to being

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[15] Nov. Org. i. 85.

but little engaged in business, Bacon, if not already actually appointed Solicitor General [16], was using all his influence to obtain the office, and was certainly recognised, on all sides, as amongst the foremost men both at the Bar and in Parliament. How little idea Liebig could have had of the pressure of public life in England, of the nature of the office of Solicitor General, or of the state of public business at this time, it is quite unnecessary for me to point out to any English reader. Moreover, Bacon's mind was already full of his philosophical projects and of the great revolution which he was to accomplish in the study of nature. Was it likely that he would waste his time in turning into Latin a work which already existed in English?

Such is the exceedingly slender character of the negative evidence on which we are required to accept the very sweeping assertion, that Bacon could not write Latin and that all his works were originally composed in English!

But, with respect to the Novum Organum, it happens that we possess positive evidence to the contrary. Archbishop Tenison (writing in 1678) states distinctly: 'The Second Part of his Great Instauration (and so considerable a part of it, that the name of the whole is given to it) is his Novum Organum Scientiarum, written by himself in the Latin Tongue [17].' And, to make this evidence the more weighty, it comes immediately after a description of the negotiations between Bacon and Playfer about the translation of the Advancement of Learning, and a criticism of the translation of that work, as actually made by Dr. Gilbert Wats. The evidence of Tenison I regard as almost conclusive, but it is as well, perhaps, to mention one or two subsidiary arguments. Hume (History of England, vol. vi. p. 191) states, in a criticism of Bacon's style, which shews how partial and superficial such judgments ordinarily are: 'Most of his performances were composed in Latin; though he possessed neither the elegance of that, nor of his native tongue.' Nor, till the time of Liebig (who certainly had no special means of knowledge), am I aware that any one ever questioned the Latin composition of the Novum Organum as well as of several of Bacon's other works.

Then, as M. Bouillet remarks, many of the fragments and smaller

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[16] Bacon was finally, after much delay in filling up the appointment, made Solicitor General on June 25, 1607. Playfer died, Feb. 2, 1608-9. The letter of Bacon to Playfer was, according to Mr. Spedding, 'certainly written "somewhile" after November 1605, when the Advancement of Learning was published ('a good while since,' according to Bacon himself), and certainly *not* after July 1608.'

[17] Baconiana, pp. 28, 29.

pieces, such as the Sententiae Duodecim, the Temporis Partus Masculus, the Inquisitio de Motu, &c., are written in Latin, and it is hardly likely that Bacon would have thought it worth while to have these imperfect essays translated for him.

Again, I may mention that the MS. of the Cogitata et Visa, which I have personally inspected, is corrected throughout in Bacon's own hand-writing, and in such a manner as to shew that he was perfectly familiar with the proprieties of Latin composition [18]. Moreover, in the Commentarius Solutus, or Bacon's Common-Place Book, now in the British Museum (Add. MS. 27,278), the entries are made almost indifferently in English and Latin.

Lastly, the Latin of, at least, the First Book of the Novum Organum, rugged and unclassical as it often is [19], seems to me so distinctly to bear the mark of genius, and of the same kind of genius that we find stamped on Bacon's English expression, that I should feel it very difficult to refer it to any of the men who surrounded Bacon rather than to Bacon himself.

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§ 5. BACON'S GENERAL PHILOSOPHICAL OPINIONS.

Bacon was not the founder of a philosophical school. Indeed, there is no character which he would himself have more indignantly repudiated. 'Primo itaque postulandum videtur, ne existiment homines, nos, more antiquorum Graecorum, aut quorundam novorum hominum, sectam aliquam in philosophia condere velle [20].' But, though not the founder of any special school of philosophy, it seems to me unquestionable that his exposition of his method, and, perhaps, also individual expressions in his writings, contributed in no small degree to the creation of what is commonly called the empirical

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[18] It may be noticed that in Bacon's letter to Andrewes (Spedding's Letters and Life, vol. iv. p. 141), he asks his correspondent 'to mark unto me whatsoever shall seem unto you either not current in the style,' &c. This is hardly the language of a man who was not himself responsible for the style. Cp. the Postscript to Bodley's Letter to Bacon, published in 'Remains,' pp. 85–87.

[19] That Bacon had formed for himself an ideal of Latin composition, for the purposes for which he required it, and an ideal just such as we find exemplified in the Novum Organum, is plain from the account given by Tenison (Baconiana, p. 26) of his discontent with Dr. Playfer's performance: 'Upon this great occasion he' (Dr. Playfer) 'would be over-accurate; and he sent a Specimen of such superfine Latinity that the Lord Bacon did not encourage him to labour further in that work, in the penning of which he desired not so much neat and polite, as clear, masculine, and apt expression.'

[20] Nov. Org. i. 116.

school of English philosophy. As, however, I have discussed this question in the sections on the Influence and Value of Bacon's writings, it is unnecessary that I should also dwell upon it here. It may be enough to say that, like Socrates, he rather gave an impulse and suggested lines of thought to others, than elaborated a definite system of his own.

But, at the same time, it is interesting to ask what the opinions of Bacon were, so far as we can gather them, on the controverted questions of psychology, ontology, and ethics. Now, as to what, for want of a better name, may be called ontological or metaphysical questions, the questions, namely, which relate to the origin and essential nature of matter and mind, and the relation between the two, his ordinary attitude is that of a disinterested, if not a contemptuous, silence. The passage just cited proceeds as follows: 'Neque enim hoc agimus; neque etiam multum interesse putamus ad hominum fortunas quales quis opiniones abstractas de natura et rerum principiis habeat; neque dubium est, quin multa hujusmodi et vetera revocari et nova introduci possint; quemadmodum et complura themata coeli supponi possunt, quae cum phaenomenis sat bene conveniunt, inter se tamen dissentiunt.' A deep sense of the unprofitable character of these speculations has, indeed, been a characteristic not of the Baconian philosophy only, but of British philosophy in general, which, with a healthy instinct, has usually either avoided them altogether or discussed them solely with the view of shewing that they lie outside the limits of human knowledge. An apparent exception is, perhaps, to be found in Bacon's constant recurrence to the doctrines of the Atomists, as to the atoms and the void. But these, properly speaking, are questions of physics rather than of metaphysics. On the standing feud between what are, somewhat uncouthly, called the Idealists, the Materialists, and the Dualists, there is, so far as I am aware, no formal discussion in Bacon's writings, unless we count the passage in the De Principiis atque Originibus (E. and S., vol. iii. p. 110), in which, quite sincerely as I believe, he adopts the scriptural doctrine of creation out of nothing by the omnipotent power of God. 'Tria enim videntur esse dogmata quae scimus ex fide circa hanc rem. Primo, quod materia creata sit ex nihilo. Secundo, quod eductio systematis fuerit per verbum omnipotentiae, neque quod materia se ipsa eduxerit e chao in schematismum illum. Tertio, quod schematismus ille (ante praevaricationem) fuerit optimus ex iis quae materia (qualis creata erat) suscipere posset. At philosophiae illae ad nullum horum adscendere potuerunt. * * * * In his itaque fidei atque ejus firmamentis standum.'

The fact is that Bacon lived too early or too late to take any serious part in these metaphysical discussions. In their scholastic form they had become discredited, and their new form, under which they were to exercise so much of the best thought of the two succeeding centuries, had not yet been impressed on them by the genius of Descartes. Bacon assumes the ordinary distinction of mind and matter, an universe of objects to be known and a thinking subject capable, with due care and discipline, of attaining to a knowledge of them, without, apparently, troubling himself as to the ulterior questions, what is knowledge, how can I become conscious of that which is not myself, and what are the ultimate meaning and relation of the two terms in this comparison.

On questions of psychology, as distinct from metaphysics, we find a fair number of passages in Bacon's writings. The most important perhaps of these are those in which, following Telesius [21], he asserts the duality of the human soul. Man, according to this doctrine (which is stated most fully in De Augmentis, iv. 3), has two souls, one peculiar to himself, the rational soul which he derives from the breath of God, the other, shared by him in common with the brutes, the irrational soul, which comes from 'the wombs of the elements.' 'Veniamus ad doctrinam de Anima Humana; e cujus thesauris omnes caeterae doctrinae depromptae sunt. Ejus duae sunt partes; altera tractat de Anima Rationali, quae divina est; altera de Irrationali, quae communis est cum brutis. Notavimus autem paulo superius (ubi de Formis loquebamur) differentes illas duas Animarum emanationes, quae in prima utriusque creatione se dant conspiciendas; nimirum, quod altera ortum habuerit a Spiraculo Dei, altera e Matricibus Elementorum. Nam de Animae Rationalis generatione primitiva ita ait Scriptura, *Formavit hominem de limo terrae, et spiravit in faciem ejus spiraculum vitae.* At generatio Animae Irrationalis, sive Brutorum, facta est per verba illa, *Producat aqua; Producat terra;* haec autem Anima (qualis est in homine) Animae Rationali organum tantum est, atque originem habet et ipsa quoque, quemadmodum in brutis, e limo terrae. Neque enim dictum est, *Formavit corpus hominis de limo terrae,* sed *Formavit hominem;* integrum scilicet hominem, excepto illo spiraculo. Quamobrem partem primam doctrinae generalis circa Animam Humanam, doctrinam de Spiraculo

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[21] On the doctrine of Telesius, and the points in which Bacon does not follow it, see Mr. Ellis's General Preface to the Philosophical Works, vol. i. pp. 49–53.

appellabimus; Secundam vero, doctrinam de Animâ Sensibili sive Producta. Neque tamen, cum hactenus Philosophiam solam tractemus (quippe Sacram Theologiam in fine operis collocavimus) partitionem istam a Theologia mutuaremus, nisi etiam cum principiis Philosophiae conveniret. Plurimae enim et maximae sunt Animae Humanae praecellentiae supra animas brutorum, etiam philosophantibus secundum sensum manifestae. Ubicunque autem tot et tantarum invenitur excellentiarum symbolum, ibi merito semper constitui debet differentia specifica. Itaque nobis non nimium placet confusa illa et promiscua philosophorum de Animae Functionibus tractatio; ac si Anima Humana gradu potius quam specie discriminata esset ab anima brutorum; non aliter quam sol inter astra, aut aurum inter metalla.' This theory of the material generation of the lower soul may not unnaturally have contributed to the formation of materialistic hypotheses as to the nature of the soul in general amongst Bacon's successors, with whom the twofold division disappeared, remote as I believe this conclusion to have been from his own views [22].

The enquiry into the 'substance' of the rational soul is a matter rather for theology than philosophy; 'ab eadem inspiratione divina hauriatur [cognitio de Substantia Animae Rationalis], a qua Substantia Animae primo emanavit.' But the doctrine concerning the sensible or produced soul is a fit subject of enquiry in philosophy, even as regards its substance. 'Anima siquidem Sensibilis sive Brutorum plane substantia corporea censenda est, a calore attenuata et facta invisibilis.' It is, in fact, compounded of flame and air ('ex natura flammea et aerea conflata') [23]. This soul, which, in man, is merely the instrument of the rational soul, might more fitly be termed 'Spirit.'

Quitting these theories, which to us appear so strange, we may note Bacon's enumeration of the principal faculties ('Facultates Animae'): 'Intellectus, Ratio, Phantasia, Memoria, Appetitus, Voluntas, denique universae illae, circa quas versantur scientiae Logicae et Ethicae [24].' Of these he says we ought, in the 'Doctrina de Anima,' to discuss ('tractare') the 'Origines,' 'idque physice' (or, as we should now say, 'psychologically'), 'prout animae innatae sint et adhaereant.'

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[22] The materialistic tendency of Bacon's philosophy is, I think, exaggerated by Lange. See Geschichte des Materialismus, 2nd ed., vol. i. pp. 194–199, and other places. Lange, who seems too ready to accept Liebig's conclusions, does scant justice to Bacon's merits.

[23] De Augm. iv. 3. E. and S., vol. i. p. 606.

[24] Id., p. 607.

'In hac parte,' he adds, 'nihil egregii (ut nobis videtur) adhuc repertum est.' The faculties of Memory, Imagination, and Reason are made the basis of the general divisions of Learning into History, Poetry, and Philosophy. 'Intellectus' or Understanding seems to be the generic term including Memory, Imagination, and Reason [25]. As distinct from the 'Doctrina de Anima' (or, as we should now say, Psychology), there are two arts which treat of the use and objects of the mental faculties. These are Logic and Ethic. 'Logica de Intellectu et Ratione; Ethica de Voluntate, Appetitu, et Affectibus disserit: altera Decreta, altera Actiones progignit.' Imagination exercises the functions of a messenger or intermediary in both departments, that of Reason and that of Will. 'Nam Sensus idola omnigena Phantasiae tradit, de quibus postea Ratio judicat: at Ratio vicissim idola electa et probata Phantasiae transmittit, priusquam fiat executio decreti [26].'

It may be noticed that the sharp line of demarcation drawn here and in similar passages between the offices of the so-called 'faculties' was a common feature of the philosophy of the seventeenth and eighteenth centuries, and has only been replaced in comparatively recent times by a more just appreciation of the complexity of our various mental operations and of the number of elements which go to make up some even of those psychical acts which at first sight appear the simplest.

Passing over the very curious remarks which Bacon makes on 'Natural Divination' and 'Fascination' (the two 'appendices,' as he calls them, to the part 'De Facultatibus Animae'), I may direct special attention to the distinction which he draws between Perception and Sense, a distinction which he notes as deficient 'in this doctrine.' This distinction is not the same as that drawn by later philosophers between Perception and Sensation [27], but corresponds rather with that between unconscious or reflex actions and conscious affections. As instances of the former, he gives the attraction of the magnet, the

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[25] See Advancement of Learning, bk. ii. (E. and S., vol. iii. p. 329): 'The parts of human learning have reference to the three parts of Man's Understanding, which is the seat of learning: History to his Memory, Poesy to his Imagination, and Philosophy to his Reason.' In the corresponding part of the De Augmentis (lib. ii. cap. 1), the word 'Understanding' is replaced by 'Anima Rationalis.'

[26] De Augmentis, lib. v. cap. 1.

[27] I confess that I cannot understand how Rémusat can have been so utterly mistaken (see p. 270, n. 1), as to suppose that Bacon uses these terms in the same sense as Reid and Stewart.

union of two bubbles, &c., in the case of insensible bodies, and, in the case of sensible bodies, the digestion of food, the beating of the heart and pulse, &c.

That the only source of our ordinary knowledge is to be found in experience Bacon seems to assume throughout his works[28], though he never, so far as I recollect, attempts to ascertain the conditions of experience or to analyse it into the elements of which it consists. The source of some portions of our knowledge, such as that of 'the substance of the rational soul[29]' and of moral principles[30], is referred to Divine Inspiration, but this, I think, is usually the inspiration of the Bible, given once for all, rather than any constant illumination specially imparted to the individual. In one place, however, at least, (De Augm. lib. ix.; E. and S. vol. i. p. 831[31]), he does undoubtedly refer our moral sentiments to a sort of divine influence, acting immediately and without any dependence on the ordinary avenues of knowledge. 'Notandum tamen, *Lumen Naturae* duplici significatione accipi; primo, quatenus oritur ex sensu, inductione, ratione, argumentis, secundum leges coeli ac terrae; secundo, quatenus animae humanae interno affulget instinctu, secundum legem conscientiae; quae scintilla quaedam est, et tanquam reliquiae, pristinae et primitivae puritatis. In quo posteriore sensu praecipue particeps est anima lucis nonnullae ad perfectionem intuendam et discernendam legis moralis; quae tamen lux non prorsus clara sit, sed ejusmodi ut potius vitia quadamtenus redarguat, quam de officiis plene informet.' Here we seem to have a third source of knowledge, corresponding almost exactly to what Butler calls 'conscience[32],' in addition to the 'Sense' and 'Divine Inspiration' (there confined to Theology) which are spoken of as if the sole sources at the beginning of De Augmentis, bk. iii.

It is impossible not to see in these speculations, crude as some of

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[28] See, for instance, Nov. Org. i. 1, 19-22; De Augm. iii. 1 ad init.: 'Omnis enim scientia duplicem sortitur informationem. Una inspiratur divinitus, altera oritur a sensu. . . . . Partiemur igitur scientiam in Theologiam et Philosophiam;' Distributio Operis (p. 170 of this edition), 'Sensus, a quo omnia in naturalibus petenda sunt, nisi forte libeat insanire.'

[29] De Augm. iv. 3 (E. and S., vol. i. p. 606).

[30] De Augm. vii. 3 (vol. i. p. 732); ix. (pp. 830, 831).

[31] Cp. Advancement of Learning, bk. ii. (E. and S., vol. iii. p. 479).

[32] This faint glimmering, as it were, of a primitive light may be one of the excellencies of the Rational Soul, spoken of in De Augm. iv. 3 ad init.: 'Plurimae enim et maximae sunt Animae Humanae praecellentiae supra animas brutorum, etiam philosophantibus secundum sensum manifestae.'

them are, the beginnings of much of the later English psychology which became so famous in the hands of Locke, Hume, Reid, and others. Besides the points already noticed I might also draw attention to the conception that Logic, Ethics, and Politics ought to be treated inductively[33], the striking contribution towards a theory of Memory and Association which occurs in Novum Organum, ii. 26, and, above all, the invaluable Aphorisms in the first book of the Novum Organum on the Idola Tribus and the Idola Specus[34].

Bacon's Moral Philosophy is mainly contained in the seventh book of the De Augmentis, and has, perhaps, hardly received the attention which it deserves. As Logic treats of the Intellect, Ethics treats of the Will[35]. 'Voluntatem gubernat recta ratio, seducit bonum apparens. Voluntatis stimuli affectus; ministri, organa et motus voluntarii.' Ethics may be divided into two principal doctrines, one treating of the exemplar or image of good, the other (to which he gives the fanciful title of 'Georgica Animi') of the regulation and culture of the mind. He finds fault with previous philosophers for not having carried their enquiries deeper, by searching for the roots of good and evil, and the very fibres of those roots; 'Ante omnia, si Naturam Rerum non minus quam Axiomata Moralia consuluissent, doctrinas suas minus prolixas, magis autem profundas reddidissent[36].' Good is either public or private, and the appetite to these two kinds of good is native to the human mind, and, indeed, to everything which exists. 'Inditus est atque impressus unicuique rei appetitus ad duplicem Naturam Boni: alteram, qua res Totum quiddam est in seipsa; alteram, qua est Pars Totius alicujus Majoris. Atque posterior haec illa altera dignior est et potentior; cum tendat ad conservationem Formae Amplioris. Nominetur prima *Bonum Individuale* sive *Suitatis*; posterior *Bonum Communionis*.' Those who are at all acquainted with

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[33] See Novum Organum, i. 127.

[34] On the connection between the mind and body, and the localisation of various moral qualities and intellectual faculties, see a curious passage in De Augmentis, iv. 1, especially towards the end.

[35] In De Augmentis, vi. 3 (E. and S., vol. i. p. 671), there is a good statement of the respective ends of Logic and Ethics. 'Finis enim Dialecticae est docere formam argumentorum, ad praesidia intellectus, non ad insidias. Finis itidem Ethicae affectus ita componere, ut rationi militent, non autem eam invadant.'

[36] At the same time, he nowhere expressly discusses the fundamental questions of Morals, such as the grounds of Moral Obligation or the nature of the Moral Faculty, unless, indeed, we make an exception in favour of the few words devoted to the 'internus instinctus,' referred to just above.

the subsequent development of Moral Philosophy in England will not fail to find in this sentence the germ of one of the leading ideas in the systems of Shaftesbury, Hutcheson, and so many other English writers.

With the more minute divisions of Good, and with the details of Bacon's moral system generally, I need not trouble the reader, who can easily consult this part of the De Augmentis for himself.

There are, however, one or two points which deserve special notice. Thus, Bacon, like all other English writers, down, I believe, to the time of Hobbes, makes morality ultimately dependent on theology. Ethics is the hand-maid of theology, and, though it may contain much useful instruction within its own limits, it must always be subservient to the master-science. 'Quod si quis objiciat animorum curationem Theologiae Sacrae munus esse, verissimum est quod asserit; attamen Philosophiam Moralem in famulitium Theologiae recipi instar ancillae prudentis et pedissequae fidelis, quae ad omnes ejus nutus praesto sit et ministret, quid prohibeat? Etenim quemadmodum in Psalmo habetur, quod *oculi ancillae perpetuo ad manus dominae respiciunt*, cum tamen minime dubium sit, quin haud pauca ancillae judicio et curae relinquantur; eodem modo et Ethica obsequium Theologiae omnino praestare debet, ejusque praeceptis morigera esse; ita tamen ut et ipsa, intra suos limites, haud pauca sana et utilia documenta continere possit[37].' Of course, this point of view is hardly consistent with the comprehension of ethics under the sciences admitting of an inductive treatment[38], but, then, at this stage in the history of ethical thought, we must not expect consistency, except in writers, like Hobbes, who had devoted special attention to the ultimate grounds of moral and political ideas. An inconsistency of another kind may be found in Bacon's anxiety to liberate natural philosophy from the control of theology, notwithstanding his readiness to subordinate to that science moral philosophy and, as we have seen, even a portion of psychology.

It may be noticed also that Bacon finds a special argument for the divine origin of the Christian religion in its marked preference of the common to the individual good. 'Nulla omnibus saeculis reperta est vel philosophia vel secta vel religio vel lex aut disciplina, quae in tantum Communionis Bonum exaltavit, Bonum vero Individuale depressit, quantum Sancta Fides Christiana; unde liquido pateat unum

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[37] De Augmentis, vii. 3.

[38] See Nov. Org. i. 127.

eundemque Deum fuisse, qui creaturis leges illas Naturae, hominibus vero legem Christianam dedisset [39].'

It is a remark very characteristic of Bacon's point of view that the superiority of the public to the private good determines the controversy as to the relative advantages of the practical and contemplative life in favour of the former. For the reasons, he says, adduced by Aristotle in favour of the latter have respect only to private good and the pleasure or dignity of the individual. Nor, if the monastic life had been regarded as merely and strictly contemplative, could any doubt on this question have ever arisen in the church: 'Contemplativam vero quod attinet meram, et in seipsa terminatam, quaeque radios nullos sive caloris sive luminis in societatem humanam diffundat; nescit eam certe Theologia [40].'

In concluding this section, I must again remind the reader that Bacon's merit does not consist in his philosophical teaching in the proper sense of the term, but in his assertion of the necessity of a new method, of a new range of studies, of a new spirit of enquiry. He was a logician, in the widest and fullest sense of the word. A philosopher he did not claim to be; and though I believe that his works exerted a very powerful influence on the philosophical speculations of the two succeeding centuries, a philosopher, in the strict sense of the term, he was not.

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§ 6. BACON'S SCIENTIFIC ATTAINMENTS AND OPINIONS, WITH SPECIAL REFERENCE TO THE STATE OF KNOWLEDGE IN HIS TIME.

Of the many charges brought against Bacon, as a philosopher and a reformer of science, there are three, connected with the present subject, which it would be vain to deny, though, in the course of this enquiry, we may find something to plead in extenuation of them. The first is that he was a Dilettante in science. The second, that he was imperfectly acquainted with the existing state of knowledge. The third, that he grossly exaggerated the defects of his own time, which, in spite of all that he says, was really one of great and fruitful intellectual activity.

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[39] De Augmentis, vii. 1.
[40] De Augm vii. 1 (E. and S., vol. i. pp. 718, 719).

This section (which must necessarily be far briefer than its importance demands, though I trust that its omissions will, to a great extent, be supplied in the notes on the Novum Organum itself) cannot be more appropriately commenced than by the following sketch of Bacon's errors and omissions, traced, it must be remembered, by the not unfriendly hand of Mr. Spedding [41]:

'It is impossible, I think, to read Mr. Ellis's remarks upon those parts of his works in which he comes in contact with what we call the *exact sciences*,—mathematics, for instance, and mechanics,—and not to feel that in the faculty of *distinguishing differences*,—the faculty whose office is (as he describes it in the Novum Organum, i. 55) *figere contemplationes, et morari et haerere in omni subtilitate differentiarum*,—he was (comparatively at least) deficient. This appears both from the imperfect account of the existing condition of those sciences which he gives in the De Augmentis Scientiarum; no notice being there taken of some of the most important advances which had been made by the writers immediately preceding him; and from his own experiments and speculations upon subjects which required their help. Though he paid great attention to Astronomy, discussed carefully the methods in which it ought to be studied, constructed for the satisfaction of his own mind an elaborate theory of the heavens, and listened eagerly for the news from the stars brought by Galileo's telescope, he appears to have been utterly ignorant of the discoveries which had just been made by Kepler's calculations [42]. Though he complained in 1623 of the want of compendious methods for facilitating arithmetical computations, especially with regard to the doctrine of Series, and fully recognised the importance of them as an aid to physical enquiries; he does not say a word about Napier's Logarithms, which had been published only nine years before and

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[41] Preface to the De Interpretatione Naturae Prooemium, vol. iii. pp. 510–512. The whole of this Preface is very interesting. Mr. Spedding ascribes Bacon's mental defects and his ignorance of so many scientific details mainly to the great predominance, in his mind, of the discursive over the critical faculty, the faculty which detects the broader resemblances and more striking analogies of things ove that which notes differences and patiently studies particular facts.

[42] See Mr. Ellis's Preface to the Descriptio Globi Intellectualis. [Vol. iii. pp. 723, 724. 'The treatise De Stella Martis was published in 1609, and became known in England at least as early as 1610. Harriot, it appears from Professor Rigaud's account of his papers, was then in correspondence with Kepler, and repeated his calculations That Bacon was acquainted with his writings we can hardly believe; they bear so directly on the questions which he has discussed that he could scarcely have neglected to notice them, had he known them even by report.']

reprinted more than once in the interval[43]. He complained that no considerable advance had been made in Geometry beyond Euclid, without taking any notice of what had been done by Archimedes and Apollonius[44]. He saw the importance of determining accurately the specific gravities of different substances, and himself attempted to form a table of them by a rude process of his own, without knowing of the more scientific though still imperfect methods previously employed by Archimedes, Ghetaldus, and Porta[45]. He speaks of the εὕρηκα of Archimedes in a manner which implies that he did not clearly apprehend either the nature of the problem to be solved or the principles upon which the solution depended[46]. In reviewing

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[43] See vol. i. p. 577, note 2. [De Augm. iii. 6. 'In Arithmeticis autem, nec satis varia et commoda inventa sunt Supputationum compendia, praesertim circa Progressiones, quarum in Physicis usus est non mediocris.' On this Mr. Ellis observes in his note: 'One would certainly not infer from this remark, to which there is nothing corresponding in the Advancement of Learning, that Bacon was aware that in the interval which had elapsed since its publication, the greatest of all inventions for facilitating arithmetical computations had been made known. Napier's Logarithms were published in 1614, and reprinted on the continent in 1620; in which year Gunter's Canon of Triangles was also published. In 1618 Robert Napier's account of his father's method and Briggs's first table of Logarithms were both published. In the year succeeding that of the publication of the De Augmentis his larger tables, and probably those of Wingate, made their appearance.'

'These dates are sufficient to show how much the attention of mathematicians was given to the subject. It would almost seem as if some one, possibly Savile, had told Bacon—what was no doubt true—that the application of the doctrine of series to arithmetical computation was not as yet brought to perfection, and that he had adopted the remark without understanding the importance of the discovery to which it referred, and perhaps without being aware that any such discovery had been made.'

I may add that an English translation of Napier's Logarithms by Edward Wright was published at London in 1616, and republished in 1618.]

[44] Id. ibid., note 1. [De Augm. iii. 6. 'Quae duae artes,' sc. Geometria et Arithmetica, 'magno certe cum acumine et industria inquisitae et tractatae sunt; veruntamen et Euclidis laboribus in Geometricis nihil additum est a sequentibus, quod intervallo tot saeculorum dignum sit; et doctrina de Solidis nec a veteribus nec a modernis pro rei usu et excellentia instructa et aucta est.']

[45] See Preface to the Historia Densi et Rari, vol. ii. p. 233. [The Archimedes Promotus of Marinus Ghetaldus was published at Rome in 1603. His method of finding specific gravities has, as Mr. Ellis remarks (vol. ii. p. 230), remained in use, with certain modifications and corrections, to the present day. The first complete edition of Baptista Poeta's Natural Magic was published at Naples in 1589. Many of the 'experiments' in Bacon's Sylva Sylvarum are said by Mr. Ellis to be taken from this work. Bacon, therefore, probably became acquainted with it between writing the Historia Densi et Rari and the Sylva Sylvarum.]

[46] Id. ibid. [The whole of Mr. Ellis's Preface to the Historia Densi et Rari is so interesting with reference to this branch of science, that the student, who has sufficient leisure, should, by all means, read it.]

the progress of Mechanics, he makes no mention either of Archimedes himself, or of Stevinus, Galileo, Guldinus, or Ghetaldus [47]. He makes no allusion to the theory of Equilibrium [48]. He observes that a ball of one pound weight will fall nearly as fast through the air as a ball of two, without alluding to the theory of the acceleration of falling bodies, which had been made known by Galileo more than thirty years before [49]. He proposes an enquiry with regard to the lever,—namely, whether in a balance with arms of different length but equal weight the distance from the fulcrum has any effect upon the inclination—though the theory of the lever was as well understood in his own time as it is now [50]. In making an experiment of his own to ascertain the cause of the motion of a windmill, he overlooks an obvious circumstance which makes the experiment inconclusive, and an equally obvious variation of the same experiment which would have shown him that his theory was false [51]. He speaks of the poles of the earth as fixed, in a manner which seems to imply that he was not acquainted with the precession of the equinoxes [52]; and in another place of the north pole being above, and the south pole below, as a reason why in our hemisphere the north winds predominate over the south [53].'

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[47] See vol. i. p. 572, note 1. [De Augm. iii. 5. For the contributions of Archimedes to mechanical and hydrostatical science, see Whewell's History of the Inductive Sciences, bk. ii. ch. 1, and for those of Galileo and Stevinus, bk. vi. chs. 1, 2. I refer to the third edition. For Ghetaldus, who is not mentioned by Whewell or Libri, or even in the Biographie Universelle, see Mr. Ellis's Preface to the Historia Densi et Rari, pp. 229–232, and Montucla, ed. of 1799, &c, ii. 5. The work of Guldinus, De Motu Terrae, &c., was not published till 1622, and his more celebrated work, Centrobarytica, &c, not till 1635. Hence, Bacon may surely, in this case, be excused for his ignorance. For an account of Guldinus and his discoveries, see Montucla, ii. 31–36.]

[48] Id. p. 578, note 1. [As Mr. Ellis says, this theory is as old as the time of Archimedes, and, therefore, Bacon's silence is the more remarkable.]

[49] Id. p. 625, note 2. [Galileo's experiments on Falling Bodies were made at Pisa between 1589-1592. It is only fair, however, to Bacon to add that, though these experiments were known to many scientific men, Galileo did not publish any account of them till the appearance of his Dialogues in 1632.]

[50] Vol. i. p. 638, note 2. [De Augm. v. 3. Topic (10). The principle of the lever, in fact, had been known from the days of Archimedes (who lived B.C. 287–212) downwards.]

[51] See Preface to Historia Ventorum, vol. ii. p. 6. [The experiments are described by Bacon in the Historia Ventorum, E. and S., vol. ii. pp. 64, 65.]

[52] Vol. i. p. 343, note 3. [Nov. Org. ii. 48 (14).]

[53] Vol. ii. p. 28, note 1. [Historia Ventorum.] I may notice that, in annotating the above quotation, I have invariably preserved Mr. Spedding's foot-notes, or rather references, giving my own additions within brackets.

'This list, for which I am entirely indebted to Mr. Ellis's prefaces and notes, might probably be increased; but the instances enumerated are sufficient to shew not only that Bacon was ill read in the history of these branches of learning, (and yet it was in this direction that science was making the most real and rapid advances,) but also that upon such subjects his ideas were not clear; this latter defect being no doubt the cause of the other; for where he could not readily follow the steps of the investigation, he could hardly appreciate the value of the result.'

To this list, formidable as it is, might be added a number of beliefs in which Bacon was certainly not superior to the current opinions of his time. Thus, he is evidently a believer, not only in Natural but Judicial Astrology, though, it must be owned, with a certain amount of hesitation and discrimination. See the long and remarkable passage in De Augmentis, lib. iii. cap. 4 (E. and S., vol. i. pp. 554–560). After beginning with the very true remark, 'At Astrologia multa superstitione referta est, ut vix aliquid sanum in ea reperiatur,' and rejecting various branches of the pretended science, he, nevertheless, allows that the study of the stars may enable us to predict not only natural events, like floods, frosts, droughts, earthquakes, &c., but 'wars, seditions, schisms, transmigrations of peoples, and, in short, all commotions or great revolutions of things, natural as well as civil.' 'Neque Electiones prorsus rejiciendae sunt; sed parcius illis quam Praedictionibus fidendum. Videmus enim in plantationibus et seminationibus et insitionibus, aetatum lunae observationes non esse res omnino frivolas [54].'

To the curious and absurd speculations on 'spirit,' which abound in the Novum Organum and elsewhere, and many of which seem to have been derived from Paracelsus, I shall frequently have occasion to call attention in the notes. A typical passage may be found in Novum Organum, ii. 40.

Though Patricius had already, in the most scornful language, attacked the Peripatetic doctrine of the transmutability of the elements, Bacon evidently believed that air and water, under certain conditions, were mutually convertible. Thus in the Novum Organum, ii. 48 (11),

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[54] Cp. Nov. Org. ii. 50 (6) (δ), 'Neque omittendi sunt consensus inter motus et affectus lunae, et passiones corporum inferiorum, prout ex experimentis agriculturae, nauticae, et medicinae, aut alias, cum delectu severo et sincero colligi et recipi possint.'

on which see my note, he absurdly speaks of air, 'qui super aquam et aquea multiplicat se, et generat novum aerem,' while air, though a fixed body in the parts immediately above the earth, is resolved again into water in the upper regions of the atmosphere [55].

Connected with this idea of the transmutability of air and water is the strange theory, which he appears to have received without question, that fountains originate in the condensation of air within the hollow parts of the earth. See Historia Densi et Rari (E. and S., vol. ii. p. 293), and Novum Organum, ii. 50 (3), with my note on the latter passage.

The transmutability of metals was another fancy which Bacon, in part at least, accepted. Thus, in the Historia Densi et Rari (E. and S., vol. ii. pp. 250, 251), though he doubts the possibility of manufacturing gold, on account of its great weight and density, he has great hopes of producing silver by the conversion of lead or quicksilver: 'Verum versio argenti vivi aut plumbi in argentum (cum argentum sit illis rarius) habenda est pro sperabili; cum tantum fixationem et alia quaedam innuat, non densationem.' In the Sylva Sylvarum (Exps. 326—328), however, though he finds much fault with many of the fanciful conceits of the Alchemists, his hopes seem to have risen, and he actually proposes a recipe for the purpose. The general question of the transformation of bodies is discussed in Nov. Org. ii. 5. This fancy, or, as, perhaps, we might rather call it, sanguine expectation, I am not inclined to visit very severely on Bacon. Though we may not be able to superinduce the 'forms' of the various 'simple natures' which constitute gold, yet, if we could discover that it was a compound, we might be able to put together the elements of which it consists, and thus produce it artificially. Moreover, an error which was shared with Boyle, whose special business was with this class of questions, and treated without disrespect by Newton [56], may well be pardoned to Bacon, who did not

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[55] Cp Historia Densi et Rari (E. and S., vol. ii. p. 293) with Historia Vitae et Mortis (E. and S., vol. ii. p. 225).

[56] Mr. Macvey Napier (Essay on Bacon, p. 7) calls attention to a letter from Newton to Oldenburg, then Secretary of the Royal Society, on certain experiments recently made by Boyle with reference to this subject. This letter, which contains a gentle criticism of Boyle's investigations, not unmixed with irony, but by no means treating the problem as an absurd or insoluble one, is printed in the General Dictionary, Historical and Critical, based on Bayle, by Bernard, Birch, &c., London, 1735, vol. iii. p. 558. In the note on this and the preceding page are several extracts from Boyle's papers, letters, &c. Boyle was certainly quite as much a believer in the transmutation of the metals, and on much the same grounds, as

claim more than a general acquaintance with the special branches of science.

It is less excusable, whether we put it down to lack of curiosity, to personal jealousy, or to want of sufficient appreciation of its importance, that Bacon makes no mention of Harvey's great discovery of the Circulation of the Blood. As Harvey began to teach this doctrine in 1619, and as he was court-physician to James I, it is difficult to suppose that Bacon had heard nothing of it[57].

Though the true theory of the Motion of Projectiles had not been distinctly stated till the publication of Galileo's Dialogues on Motion in 1638, still the speculations of Tartalea, Digges, &c., ought, if they had been known to Bacon, to have saved him from shewing such complete ignorance, when treating of the subject, as he exhibits in Nov. Org. ii. 36 (6), ii. 48 ad fin., and other places[58]. It is curious that one of the books (the Pantometria, published in 1591), in which Digges speaks of the compound motion of a projectile, was dedicated to Bacon's father.

Notwithstanding his frequent criticisms of the Peripatetic doctrine of Motion, it is plain that Bacon entertained no doubt of the 'latio gravium versus terram, et levium versus ambitum coeli[59],' or of the existence of bodies having positive levity. In fact, in Nov. Org. ii. 35, he repeats, in almost the precise words of Aristotle himself, the Aristotelian division of what is called 'motion of translation' (φορά), and sums up his account with the words 'Atque ista pulchra dictu sunt.' And though, with respect to the circular and eternal motion of the heavenly bodies, he impugns Aristotle's theory in the Descriptio Globi Intellectualis[60], I am not aware of any passage in which it appears to occur to him that the received division of light and heavy, and the two kinds of motion founded thereon, may be without

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Bacon. See some curious passages in his Works, vol. ii. pp. 515, 516; vol. iii. p. 621 (ed. of 1744). In the former passage, he seems to entertain no kind of doubt that he has produced silver out of gold, 'or at least a new kind of metal very different from gold.' Then, he concludes generally 'that there may be a real transmutation of one metal into another, even among the perfectest and noblest metals, and that effected by factitious agents in a short time, and, if I may so speak, after a mechanical manner.'

[57] In the Historia Densi et Rari, and in the very part which was probably written during Bacon's last 'quinquennium,' he thinks it a sufficient account of pulsation in the heart and arteries of animals, to say that it is due to the endless and alternate dilatation and contraction of the spirits. See E. and S., vol. ii. p. 263.

[58] See my notes on these two passages, especially the latter.

[59] Nov. Org. ii. 46.

[60] See my note on the passage on motion in Nov. Org. ii. 35.

foundation[61]. At the same time, considering the obscurity of the views of motion which then prevailed, and the fact that the weight of the atmosphere had not yet been discovered, we are not here so much justified in complaining of ignorance, as of a want of that insight which in a man of Bacon's genius might possibly have been expected. Connected with these opinions, are the theory that air has no weight, being indifferent as regards gravity and levity, and that flame and 'living spirits' are positively light[62].

Passing to a very different subject, we find that, of the triad of Paracelsus, sulphur, mercury, and salt, Bacon adopts two principles, namely sulphur and mercury, as pervading the universe (quasi per universitatem rerum permeare), and being the very foundation of matter (naturas admodum primordiales, et penitissimos materiae schematismos; et inter Formas Primae Classis fere praecipuas)[63]. The mode in which he traces these principles through all things in heaven and earth and under the earth appears to us peculiarly absurd. He omits Salt, as compounded of the two others, but, in doing so, can hardly be said to have improved on the theory of Valentinus and Paracelsus. In two notes on Nov. Org. ii. 50 (6) ad init., I have spoken at such length on the history of this dogma, and the manner in which Bacon presents it in various parts of his works, that it would be superfluous to say anything further on the subject in this place.

That in the Sylva Sylvarum (on which, however, see the apologetic remarks of Rawley in his preface to the work[64]) Bacon affords his countenance to many of the most absurd fancies of his time, is a fact so well known and so universally confessed, that it hardly requires illustration.

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[61] He certainly criticises the explanations given (Nov. Org. ii. 35), but he does not call in question the supposed facts themselves. It should, perhaps, also be mentioned that he does not recognise in air and similar bodies 'tam fortis appetitus petendi superiora, quam putatur.' Historia Densi et Rari (E. and S., vol. ii. p. 255).

[62] Animal spirits, as being compounded of air and flame, are intermediate, in point of levity, between the two. See Historia Densi et Rari (E. and S., vol. ii. pp. 255, 256). 'At spiritus vivos aere ipso aliquanto rariores existimamus: tum quia inflammantur nonnihil; tum quia diligenter experti sumus, aerem ad minuendum aut sublevandum pondus nihil conferre. . . . . . At corpus animale vivum et mortuum gravitate manifesto differunt; licet haud tantum quantum putantur. Quare videtur aer pondus non minuere; spiritus autem vivus hoc facere.'

[63] Cp. Nov. Org. ii. 50 (6) with Aditus ad Historiam Sulphuris, Mercurii, et Salis (E and S., vol. ii. p. 82).

[64] In the section on the Opponents of Bacon, I have transcribed the more important part of Rawley's Apology.

I may give as instances, the conceit that the blood-stone is good for them that bleed at the nose, with the quaere, whether 'the stone taken out of the toad's head be not of the like virtue, for the toad loveth shade and coolness[65];' the 'report' of 'the writers of natural magic,' quoted apparently with approval, that 'the heart of an ape, worn near the heart, comforteth the heart, and increaseth audacity,' 'and that the same heart likewise of an ape, applied to the neck or head, helpeth the wit, and is good for the falling sickness[66];' the statement that 'there be divers sorts of bracelets fit to comfort the spirits, and they be of three intentions, refrigerant, corroborant, and aperient[67];' the suggestion to 'try the force of imagination upon staying the working of beer when the barm is put in, or upon the coming of butter or cheese, after the churning, or the rennet be put in[68];' the sections on the influences of the moon[69]; the notion that water is congealed into crystals[70]. I might, of course, greatly extend this list, but there is no object in doing so. The reader, who is curious in such matters, may refer to the tenth century, which is full of absurdities of this kind. On Bacon's behalf, it may be pleaded that these were the fancies of his age, from which probably no man of that time was altogether free. We have only to look into books like Sir Thomas Browne's 'Vulgar and Common Errors' or the various works of Joseph Glanville, to see how persistent such notions were even in the generation after Bacon's death. Moreover, a large number of them may be grouped under the heads of 'sympathy and antipathy,' 'force of imagination,' &c., subjects on which peculiarly obscure ideas prevailed at this time. Lastly, Bacon's very hopefulness, and his sanguine expectations of what nature had in store for those who diligently studied her, may have rendered him peculiarly liable to be imposed on by these 'old wives' fables.'

But far the most important and, perhaps at first sight, the least excusable of Bacon's scientific errors was his persistent rejection of the Copernican theory[71]. It seems strange that one who laid claim to be the great reformer of science should have steadily refused to

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[65] Exp. 967. [66] Exp. 978. [67] Exp. 961. [68] Exp 992.
[69] Exps. 890–897. [70] Exp. 364. Cp. Nov. Org. ii. 48 (4).
[71] M. Bouillet, in a note on Nov. Org. ii. 36, is so much startled with this fact that he is driven to the supposition that Bacon was deterred from embracing the Copernican theory by fear of the inconvenient consequences which might thereby be entailed on him, 'surtout sous un roi aussi dévot que Jacques Ier.' But this theory appears to me hardly worth discussion.

admit the greatest reform in scientific conceptions which had been proposed for many generations, and which had already been before the world for eighty years. To say nothing of Copernicans before Copernicus [71], the views of Kopernik himself were first published in a letter by Rheticus in 1540, though his great work 'De Revolutionibus orbium coelestium' did not see the light till the very day of his death, May 24, 1543 [72]. The precise thesis maintained, it must be recollected, was that *if* the sun be regarded as the immovable centre of the universe (we now, of course, know that it is not), and the earth be supposed to have both a diurnal and an orbital motion, the *apparent* phenomena of the heavens admit of a far more simple *mathematical* explanation than on the received or Ptolemaic system [73]. Whether this hypothesis represents what really does take place, that is, whether the *mathematical* theory is also the true *physical* theory, was another question, which might be resolved differently, or left unresolved, by those who maintained the former. As Professor De Morgan says [74], 'the question whether Copernicus himself was a Copernican in the modern sense of the word is not easily settled. His phraseology is almost always that of a mathematical Copernican. In a very few places, and cautiously, he leans to the physical truth as probable, and to the diurnal motion as more probable than the orbital.' It was not till the discovery of the satellites of Jupiter by Galileo in 1609, that the Copernican system could be said to be

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[71] On which subject, see an excellent article, entitled 'Copernicus in Italy,' in No. 299 (July, 1877) of the Edinburgh Review. One of the works reviewed is I precursori del Copernico nell' Antichità. Ricerche Storiche. Di G. V. Schiaparelli. Milano, 1873.

[72] The idea of his system, however, must have occurred to him before 1507. He informs Paul the Third in his Dedication that he had kept the book by him for four times the nine years recommended by Horace.

[73] With reference to the merely hypothetical character ascribed to his reasoning, the reader will do well to consult the curious and interesting admonition 'Ad Lectorem de Hypothesibus hujus operis' prefixed to the work. This occurs in the first, as well as the subsequent editions, but it seems not to have been written by Copernicus himself. It is not necessary for the hypotheses to be true, or even probable, 'sed sufficit hoc unum, si calculum observationibus congruentem exhibeant.' The office of the astronomer is confined to observation and calculation, 'cum veras causas assequi nulla ratione possit.'

[74] In addition to the ordinary books, Delambre, Whewell, &c, the student, who has time and inclination to pursue this subject, is recommended to consult two very interesting papers by the late Professor De Morgan, one entitled, 'Old Arguments against the Motion of the Earth,' which appeared in the Companion to the British Almanac for 1836, the other, which appeared in the same publication for 1855, entitled 'Notes on the Antegalilean Copernicans.'

recommended by any other important considerations than those of its simplicity. This important discovery, which was announced to the world in the Sydereus Nuncius in 1610, irresistibly suggested an analogy between the small system of Jupiter, now ocularly demonstrated, and the large system of the Sun, as depicted theoretically by the followers of Copernicus [75]. From this point the controversy assumed a new phase, as is evidenced, amongst other things, by the increased warmth of the dispute. Even still, however, and notwithstanding the mathematical precision given to the theory by the investigations of Kepler (whose work De Motibus Stellae Martis was published in 1609), it cannot be said that, till the laws of formal astronomy were connected by Newton with the physical laws of matter and motion, the motions of the earth or its relation to the rest of the solar system could in any way be regarded as placed beyond the range of dispute. In Bacon's time, and especially during the earlier period of his life, men might be well excused who suspended their judgment, or who even preferred to adhere to the old assumption till their objections to the new theory were removed. The following sentences from Mr. De Morgan [76] are so apposite, and read a lesson so universally useful to us, in estimating the scientific judgments of men in past ages, that I am sure my readers will be grateful to me for transcribing them. 'By investing Copernicus with a system which requires Galileo, Kepler, and Newton to explain it, and their pupils to understand it, the modern astronomer refers the want of immediate acceptance of that system to ignorance, prejudice, and over adherence to antiquity. No doubt all these things can be traced; but the ignorance was of a kind which belonged equally to the partisans and to the opponents, and which fairly imposed on the propounder of the system the onus of meeting arguments, which, in the period we speak of, he did not and could not meet. It must be remembered that, in the sixteenth century, the wit of man could not imagine how, if the earth moved, a stone thrown directly upwards would tumble down upon the spot it was thrown from. Easy experiments verify the law of motion which now explains this; but to be proved by experiment, a law must be conceived and imagined. To be put under discussion, it must be proposed. Now the advocates

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[75] Even Bacon was sufficiently moved by this discovery to include among his affirmations in the Thema Coeli (E. and S., vol. iii. p. 780), 'solisequium ex natura inopiosa in ignibus infirmioribus Veneris et Mercurii; cum etiam inventae sint a Galilaeo stellulae errantes Jovis asseclae.'

[76] Companion to the British Almanac for 1855, pp. 21, 22.

of the earth's motion never, before the time of Galileo, even conceived this law, never proposed it, and of course never proved it.'

It is possible to draw up a long list of eminent men, astronomers and others, anterior to or contemporary with Bacon, who adopted and taught the Copernican theory. Such were Rheticus, Reinhold, author of the Prutenic tables (who, however, according to Delambre[77], simply made use of the observations of Copernicus for the purpose of constructing tables, and gave no opinion as to the motion of either the earth or the sun), Peter Ramus, Francis Patrizi (Patricius), Giordano Bruno, Thomas Digges, William Gilbert, Mæstlin (who, however, seems to have been mainly a mathematical Copernican), and, lastly, Kepler and Galileo themselves. But of these, some, like Patricius, Bruno, and Ramus, do not seem to have had any very good reasons for their opinions. Others, like Gilbert[78], to whom we may add Patricius, only admitted the diurnal motion of the earth, and may therefore be claimed by either side. And against this list we may put the great name of Tycho Brahé[79] (who, however, having died in 1601, did not live to become acquainted with the discoveries of Galileo), Vieta, the greatest French mathematician of the sixteenth century, as De Morgan calls him, Clavius, the learned Jesuit, probably Edward Wright, and possibly, from his silence, even Stevinus. Amongst the latest of the Anti-Copernicans were Thomas Lydiat, who died in 1646, and Riccioli, who in his Almagestum Novum, published as late as 1651, enumerated, according to Whewell[80], fifty-seven Copernican arguments, and pretended to refute them all.

The list of Anti-Copernicans, respectable as it is, is not, it must be acknowledged, equal in reputation to that of the Copernicans, but then posterity, it must be recollected, is always kinder to the winning than to the losing side. And even of the Copernicans, as we have seen, some went only half way, while others, probably, did not feel

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[77] Delambre, Histoire de l'Astronomie Moderne, tom. i. pp. 145, 146. 'Il n'a rien changé aux théories, il n'a songé qu'à perfectionner les nombres.' Still Delambre thinks that he had a preference for Copernicanism.

[78] See Descriptio Globi Intellectualis (E. and S., vol. iii. p. 742). In accordance with this opinion, as cited by Bacon and possibly orally communicated to him by Gilbert, are the silence on the orbital motion observed in the De Magnete, lib. vi. capp. 3, 4, and the enumeration of the difficulties attending the theory in the posthumous work, De Mundo Nostro Sublunari, lib. ii. cap. 20.

[79] As is well known, Tycho Brahé invented a system of his own, according to which the planets, with the exception of the moon, move round the sun, while the sun itself, with its attendant planets, moves round the earth.

[80] History of the Inductive Sciences, bk. v. ch. 3. sect. 5.

very confident of the conclusions which they had embraced. More or less of hesitation as between the two theories, or rather as between the various theories, was, perhaps, the commonest state of mind among those who were qualified to give any opinion [81], and this sometimes appears to have been the case, even with Bacon himself, though never to the extent, I believe, of actually altering the conclusions which he had formed on the subject in early life.

As to the tone in which Bacon treats this question, I cannot but think that most readers have been led to conceive an undue prejudice against him by the ill-considered statement of Hume, that 'he rejected, with the most positive disdain, the system of Copernicus [82].' That he consistently rejected the system of Copernicus throughout life, whether as to the annual or as to the diurnal motion, I certainly believe, as I have pointed out in my notes [83]; but, if we except a passage in his juvenile performance, the Praise of Knowledge, where he speaks of 'these new carmen who drive the earth about [84],' and another in the Temporis Partus Masculus [85], where, as I have so often said, he purposely states his views in an exaggerated form, I do not think that the tone in which he speaks of the Copernican theory can at all fairly be described as that of 'positive disdain.' Thus, in Nov. Org. ii. 35, his language is, 'At motus ille perennis rotationis, videtur esse coelestium proprius; statio, sive quies, videtur competere globo ipsi terrae [86].' In ii. 36 (2), he proposes the alternative between the diurnal motion of the earth and that of the heavens as a subject of serious enquiry, to which an 'instantia crucis' may be applied, though I think there is no doubt as to the side to which he himself leans. In ii. 46, speaking of the enormous velocity which must be ascribed to the heavens on the ordinary theory, he says with the

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[81] Whewell, in proof of the hesitation felt at even a late period, refers to the beginning of the 8th book of Paradise Lost (first published in 1667).

[82] Hume's History of England, Appendix to the Reign of James I.

[83] See notes on Nov. Org. ii. 36 (2), 46, 48 (17). In a note on the first of these passages, I have combated a statement made by Dr. Whewell (History of the Inductive Sciences, 3rd ed., vol. i. Additions, p. 389), that 'it would seem as if Bacon himself had a leaning to believe the diurnal motion of the earth, when he wrote this passage.'

[84] Spedding's Letters and Life, i. 124.

[85] 'An non vides (fili) tum eccentricorum et epicyclorum ingeniatores, tum terrae aurigas, aequa et ancipiti phaenomenorum advocatione gaudere?' E. and S., vol. iii. p. 536.

[86] On the real or apparent discrepancy between this and a passage in the Descriptio Globi Intellectualis, see notes on ii. 35.

greatest candour, 'quae etiam viros graves ita obstupefecit, ut mallent credere motum terrae [87].' Again, in ii. 48 (17), speaking also of the motion of the heavens, he says: 'Attamen gravis de illo motu lis est inter nonnullos tam ex antiquis quam modernis, qui rotationem terrae attribuerunt.' In the De Augmentis, iv. 1 (E. and S., vol. i. p. 580), we have a cautious and discriminating statement, which must have commended itself to many men at the time: 'Constat similiter sententiam Copernici de Rotatione Terrae (quae nunc quoque invaluit), quia phaenomenis non repugnat, ab Astronomicis Principiis non posse revinci; a Naturalis tamen Philosophiae Principiis, recte positis, posse.' In the Thema Coeli, though he sums up his opinion at the end, by saying 'Negant terram rotare,' he speaks, in the body of the work as if at one time he had actually hesitated between the two theories: 'Terra itaque stante (id enim nunc nobis videtur verius) [88].' This work, however, was written about 1612. In the De Augmentis, published in 1623, he pronounces himself far more positively: 'harum suppositionum' (sc. of the Ptolemaic System) 'absurditas in motum terrae diurnum (quod nobis constat falsissimum esse) homines impegit [89].' Even this statement, however, emphatic as it is, is far from exhibiting 'the most positive disdain.' Lastly, I ought to mention that, in the Descriptio Globi Intellectualis [90], Bacon actually advances some very cogent reasons against the Copernican theory, as it was then stated, reasons indeed so cogent that they are amongst those which have led to considerable modifications of that theory [91].

I conceive, then, with regard to this point, that, on the whole, I have made out a case, if not for acquittal, at least for very considerable mitigation of judgment. Bacon appears, in early life, like the majority, probably, of even his scientific contemporaries, to have conceived a strong prejudice against the Copernican theory. In middle life, he seems for a time to have wavered, or, at least, to have felt some hesitation, though never, I believe, to the extent of adopting the theory of the

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[87] In the next paragraph, speaking of Galileo's theory of the tides, he adds: 'Sed hoc commentus est concesso non concessibili (quod terra nempe moveatur).'

[88] E. and S., vol. iii. p. 773.

[89] De Augm. iii. 4 (E. and S., vol. i. p. 552).

[90] E. and S., vol. iii. pp. 740, 741.

[91] One of these, the triple motion of the earth, as conceived by Copernicus, seems to have been amongst the reasons which prevented Gilbert from positively adopting the theory of the orbital motion, though he was an enthusiastic adherent of the theory of the diurnal motion. See his posthumous work, referred to above, lib. ii. cap. 20.

earth's motion. The reasons against the theory, probably, appeared to him more and more decisive, till at last, with advancing age, he became positive in his opposition to it. Now, surely, this is a piece of mental history so common, and one to which we are all, in turn, so liable, that, before casting our stone at Bacon, we may at least pause to consider the circumstances of his age, the attitude with respect to the same question assumed by his contemporaries, and the amount of evidence by which the doctrine he rejected was at that time supported. To parallel cases there is no limit, but I may specially mention the tenacity with which the Cambridge mathematicians adhered to the Cartesian system long after the publication of Newton's discoveries (which, unlike those of Copernicus, possessed demonstrative force), the slowness of their reception on the continent of Europe, and the obstinate resistance offered by Leibnitz to the Newtonian doctrine of Gravitation [92]. Not only are we liable, as I have already intimated, to ascribe to a theory now fully established a degree of perfection and an amount of evidence which it did not at first possess, and then express our surprise that it was not at once universally welcomed, but we are also given to assume that the almost superstitious reverence with which we now invest the great names of the past ought to have exercised an equal influence over their contemporaries [93].

Having dwelt so long on the unfavourable side of the picture, we may now turn to the more agreeable task of considering the positive claims of Bacon to recognition in the History of Science. And, first, I must warn my readers against expecting too much. Bacon, I have acknowledged, was a Dilettante in science, and, there-

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[92] All these cases are mentioned in the last section of Playfair's Dissertation, after his account of Newton's discoveries. He enters at some length on the two former. For the last (which appears to me a much stronger case of prejudice, inveteracy of habit, or whatever we like to call it, than that of Bacon), the reader should refer to the letters which passed between Clarke and Leibnitz.

[93] It has been frequently remarked that Bacon never mentions Kepler. It is probable, as Mr. Ellis remarks, that he was not acquainted with his writings, but the mere omission of his name would find at least a parallel in the case of Descartes, who, though long posterior to Bacon, and having frequent occasion to treat of astronomical questions, makes no reference to Kepler in any part of his writings.

I may here take the opportunity of mentioning that the best account and criticism of Bacon's astronomical views in detail is to be found in Mr. Ellis's Preface to the Descriptio Globi Intellectualis, vol. iii. pp. 715–726.

fore, can hardly be expected to be a great discoverer. Nor did he lay claim to any such distinction. His business was, so to speak, with the philosophy and logic of science, rather than with the body of science itself; what he hoped to do, was not so much to advance science in his own person, as to show others how it might be advanced, and to impel them to the work. That he was successful in this mission, I think I have succeeded in shewing elsewhere [94]. But, if a Dilettante, he was a Dilettante of no ordinary kind. The wealth of illustration exhibited in the Novum Organum and the vast range of subjects reviewed in the De Augmentis shew a width of knowledge and an universality of interest which, notwithstanding all the defects we have just been enumerating, were probably equalled in the case of no other man then living. What he gained in width, he, of course, to a certain extent, lost in depth; for this is the universal law of the human intellect. He was not a Specialist, and, therefore, can hardly be said to have left his name in the annals of any particular branch of science. But, to say nothing of the place which he merits in the history of Science considered in its totality, he did, I conceive, throw out many suggestions of rare sagacity even in the particular sciences, and, in a certain sense, anticipate more recent discoveries. To some of his more remarkable anticipations of subsequent views or discoveries I shall now proceed to direct the attention of the reader.

First of all, in connection with the subject just discussed at so much length, I may mention his sagacious and possibly fertile suggestion of the necessity of a closer union between formal and physical astronomy. 'Nos nulla cum priorum inventorum jactura, tamen longe majus opus movemus; neque enim calculos aut praedictiones tantum meditamur, sed philosophiam; eam scilicet, quae de superiorum corporum non motu solummodo ejusque periodis, sed substantia quoque et omnimoda qualitate, potestate, atque influxu, intellectum humanum informare, secundum rationes naturales atque indubitatas absque traditionum superstitione et levitate possit; atque rursus in motu ipso invenire atque explicare, non quid phaenomenis sit consentaneum, sed quid in natura penitus repertum atque actu et reipsa verum sit [95].' A little further on [96] he draws a distinction between the objects of philosophy and astronomy: 'De substantia coelestium inquirit praecipue philosophia, et de causis motus eorum;

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[94] See the section on Bacon's Influence on Philosophy and Science.

[95] Descriptio Globi Intellectualis, cap. 5 (E. and S., vol. iii. p. 734).

[96] Cap. 7 (pp. 748, 749).

de motu ipso vero et ejus accidentibus, astronomia; de influxu et potestate, utraque. Debuerat autem esse cautum inter astronomiam et philosophiam, ut astronomia praeferat hypotheses quae maxime expeditae ad compendia calculorum; philosophia vero quae proxime accedunt ad veritatem naturae. * * * * Itaque cum utraque scientia (qualis nunc habetur) sit res levis et perfunctoria, fortius omnino figendus est pes; ac si ista duo, quae propter angustas hominum contemplationes, et usum professorium per tot secula disjungi consueverunt, una atque eadem res sint, atque in unum scientiae corpus conflata.' Equally or more remarkable is a passage in the De Augmentis [98], where, also insisting on the importance of Physical Astronomy, he compares mere formal astronomy with the stuffed ox of Prometheus, and insists (a most important idea) on the necessity of connecting celestial with terrestrial phenomena, of explaining what takes place in the heavens and what is seen amongst us, the one by the other. 'Quicunque enim Superlunarium et Sublunarium conficta divortia contempserit, et Materiae Appetitus et Passiones maxime Catholicas (quae in utroque globo validae sunt, et universitatem rerum transverberant) bene perspexerit, is ex illis quae apud nos cernuntur luculentam capiet de Rebus Coelestibus informationem, et ab iis e contra quae in coelo fiunt haud pauca de Motibus Inferioribus (qui nunc latent) perdiscet; non tantum quatenus hi ab illis regantur, sed quatenus habeant passiones communes. Quamobrem hanc partem Astronomiae, quae Physica est, desiderari statuimus. Eam Astronomiam Vivam nominabimus, ad differentiam bovis illius Promethei suffarcinati, et solummodo figura tenus bovis.' This passage might almost be regarded as a prediction not only of the discoveries of Newton, but of the mode in which he made them. And, though views of this kind were already beginning to be in the air, it might be maintained, not without probability, that passages such as these, so admirably expressed, so full of hope, and so rich in suggestion, had no inconsiderable share in bringing about the magnificent results achieved by the next generation. As Dr. Whewell says, 'however erroneous might be the points of Bacon's positive astronomical creed, these general views of the nature and position of the science are most sound and philosophical [99].'

From the consideration of the justness and possible influence of Bacon's views on the union of physical and formal astronomy and on

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[98] De Augmentis, iii. 4 (E. and S., vol. i. pp. 552-554).

[99] History of the Inductive Sciences, bk. vii. ch. 1.

the necessity of combining the explanations of celestial and terrestrial phenomena, we pass by a natural transition to the famous passages on Attraction. In the Lettres sur les Anglois (1728—1730), which, though they certainly did not create, undoubtedly did much to revive the celebrity of Bacon in France, Voltaire says at the end of a long eulogium: 'Mais ce qui m'a le plus surpris, c'a été de voir dans son livre en termes exprès, cette Attraction nouvelle dont M. Newton passe pour l'inventeur[1].' And the Article on Bacon in the Dictionnaire Philosophique begins: 'Le plus grand service peut-être que François Bacon ait rendu à la philosophie a été de deviner l'attraction.' This praise, as I have said in the section on Bacon's Influence on Philosophy and Science, I believe to be greatly exaggerated, for it was the discovery of the precise Law of Attraction and its illustration in so many departments of nature rather than the mere divination of its influence which constituted the peculiar merit of Newton; but, at the same time, few, I think, can read the passages in Bacon, where he alludes to this subject, and fail to recognise their remarkable character. Even allowing for Gilbert's influence[2], I think that the passage in Nov. Org. ii. 36 (3), and the Instantia Crucis there proposed (the reader will do well to study the whole of this section with care), do great credit to Bacon's sagacity, and, even if they stood alone, would entitle him to some place in the History of Science[3]. Not only does he suggest the attraction of the earth's mass as the cause of the fall of heavy bodies, but he adds that, if this be the cause, the nearer the bodies approach the earth, the more strongly and with the greater force will they be drawn towards it, while, the further off they are, the weaker and the slower will be their motions. Moreover, the experiment proposed is itself very ingenious, and is, in principle, no other than that recently used in the series of scientific observations instituted in the Dolcoath and Harton Collieries[4]. With this passage, which is, however, the most remarkable, the student may compare what Bacon says[5] on the same subject in Nov. Org. ii. 35, 37, 48 (9),

[1] Lettre xii.

[2] As I have remarked in my note on the Text, even if the idea was suggested to Bacon by the work of Gilbert, he ought, at least, to have the credit of having detached the conception of attraction from that of magnetism.

[3] See the appreciative remarks of Sir John Herschel in his Discourse on the Study of Natural Philosophy, § 196.

[4] See the remarks of Sir John Herschel referred to above, and Mr. Ellis's note on the passage. In my own note, I have pointed out certain defects in the experiment as proposed, when estimated in reference to our present state of knowledge.

[5] In this passage Bacon actually contemplates the attraction exerted by the sun

in the Aditus ad Historiam Gravis et Levis (E. and S., vol. ii. p. 80), and in the Descriptio Globi Intellectualis, cap. 7 (E. and S., vol. iii. p. 762). In the last passage, it is only fair to add, he refers to Gilbert. I may also add that in the Sylva Sylvarum, Exp. 704, Bacon shews a very just conception of the nature of gravity, when he says that it 'is a mere motion of matter, and hath no affinity with the form or kind.'

On subsidiary points connected with Astronomy, I may adduce as examples of Bacon's sagacity the fact that he saw that there must be some reason why the heavens rotate from east to west, or, as we should put it, why the earth rotates from west to east[6], the idea of the possibility of predicting comets[7], and his recognition of the probable or possible influence of the moon on the spring and neap tides[8].

In Nov. Org. ii. 46, we have the brilliant conjecture that the actual state of the starry sky precedes by an interval of time that which is apparent to us, in other words, that light requires time for its transmission. 'Atque hoc, cum similibus, nobis quandoque dubitationem peperit plane monstrosam; videlicet, utrum coeli sereni et stellati facies ad idem tempus cernatur quando vere existit, an potius aliquanto post; et utrum non sit (quatenus ad visum coelestium) non minus tempus verum, et tempus visum, quam locus verus, et locus visus, qui notatur ab astronomis in parallaxibus. Adeo incredibile nobis videbatur, species sive radios corporum coelestium per tam immensa spatia milliarium subito deferri posse ad visum; sed potius debere eas in tempore aliquo notabili delabi.' Unfortunately, Bacon proceeds to explain away his conjecture by arguments almost as perverse as the thought itself is felicitous[9].

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upon the planets: 'aut sol alliget astra Veneris et Mercurii, ne longius absint a corpore ejus, quam ad distantiam certam.'

[6] Nov. Org. ii. 48 (14). For the generalisation, or rather approximate generalisation, of this proposition, and the probable cause of the phenomenon, see my notes on the passage.

[7] De Augmentis, iv. 3 (E. and S., vol. i. p. 558). 'Praedictiones fieri possint de Cometis futuris, qui (ut nostra fert conjectura), praenunciari possunt, et de omni genere meteorum,' &c. It must be confessed, however, that he then goes on to speak of the prediction of wars, seditions, schisms, &c. Moreover, the same question was discussed in the time of Seneca, and even earlier. See Nat. Quaest., lib. vii. capp. 3, 4, 19, 25. The last of these chapters is peculiarly interesting.

[8] See Nov. Org. ii. 45, 48 (9). In my note on the former passage, I have spoken of Bacon's change of opinion on this subject. On the causes of the semi-diurnal ebb and flow he seems to have been inclined to adopt an entirely different opinion. See notes on Nov. Org. ii. 35 and 36 (1).

[9] On the Velocity of Light, see my notes on the passage quoted.

Amóngst Bacon's claims to the recognition of scientific men, a high place ought to be given to his felicitous illustration of the 'Instantiae Solitariae [10]' by the enquiry into the causes of Colour. The passage, to which, with my notes upon it, I must refer the reader, might justly be regarded as a striking anticipation of the optical investigations, afterwards so deservedly celebrated, of Newton.

In connection with the same subject, I may refer to some interesting speculations on the phenomena of Refraction in Sylva Sylvarum, Exps. 761, 762.

Both M. Bouillet and Mr. Ellis rightly call attention to the importance of an experiment, tried with a hollow globe of lead, by which Bacon attempted to determine the question of the compressibility or incompressibility of water [11]. This experiment has every appearance of having been original, and certainly preceded by nearly fifty years the celebrated experiment of a similar nature, usually called the Florentine experiment, made by the Accademia del Cimento at Florence. Both experiments were, as we now know, inconclusive, but this does not detract from the ingenuity of conception which suggested them.

Humboldt (Kosmos, vol. ii. pp. 322, 379, 380) compliments Bacon on having in his Historia Ventorum (which Humboldt dates much too late) considered the direction of the winds in connection with temperature and aqueous phenomena, and having thereby laid the foundations of a theory of the currents of the atmosphere.

Again, we find, scattered here and there in Bacon's works, profound views of nature, which recent science has done much to illustrate and confirm. Such is the implied criticism of the ordinary doctrine of species contained in the passage on Realism in Nov. Org. i. 66. Such, too, is the opinion on the ultimate constitution of bodies expressed in his atomic theory [12], and that on the ultimate condition of their parts expressed towards the end of Nov. Org. ii. 48: 'Etenim in corporibus hic apud nos nulla vera est quies, nec in integris, nec in partibus; sed tantum secundum apparentiam.' And, to give one more instance, there is shown throughout his works a

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[10] Nov. Org. ii. 22.

[11] See Nov. Org. ii. 45, 50 (2); Historia Densi et Rari (E. and S., vol. ii. pp. 299, 300). From these passages it appears that Bacon thought he had demonstrated the compressibility of water. From the Florentine experiment, so far as any conclusion at all was drawn, it was the opposite one. On the subject generally, see my notes on Nov. Org. ii. 45.

[12] Amongst many other places, see Nov. Org. ii. 7, 8.

wonderful appreciation of the combined unity and variety in Nature, as well as of the necessity of never losing sight of the one in considering the other. See, for example, Nov. Org. ii. 17, and the Instantiae Clandestinae, Monadicae, Deviantes, and Foederis to which M. Bouillet so appropriately calls attention (he might have added the Instantiae Conformes and Limitaneae) in his note on that passage.

Bacon's constant references to the new science of Magnetism, recently almost created by Gilbert, shew no unwillingness to accept novel theories, when they did not, as seemed to him to be the case with the Copernican theory, involve complex and arbitrary assumptions.

The suggestions and contributions made by Bacon to the sciences of mind and conduct seem to me neither few nor unimportant. But to these I have drawn attention in two other sections, that on his general philosophical opinions and that on his influence on Philosophy and Science.

I have reserved to the last some remarks on the investigation into the nature of Heat, which occupies so conspicuous a place in the Novum Organum. It is quite true, as Mr. Ellis points out in his General Preface [13], that the provisional conclusion adopted by Bacon in ii. 20, as his Vindemiatio Prima, is not the result of the Method of Exclusion, but rests immediately upon the three tables of Comparentia. Hence it does not pretend to be the result of formal proof, but only a sort of probable hypothesis based upon the consideration and comparison of a large number of instances. Separating, however, the question of the mode by which it was arrived at from the nature and value of the conclusion itself, I think Bacon must be credited with having in a remarkable manner anticipated one of the most beautiful and important discoveries of modern science. Stripping it of certain excrescences, the essential part of the conclusion is that Heat is an expansive motion amongst the minute particles of bodies. And this, after much speculation and experimentation, and the predominance, for a long time, of another theory, namely, that heat is a subtle fluid, called Caloric, is the precise conclusion at which the most eminent physicists have at length arrived. Professor Tyndall does Bacon the justice of quoting in an Appendix [14] a considerable portion of the

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[13] Vol. i. pp. 36, 37.

[14] See the Appendix to ch. 2 of Tyndall's Heat a Mode of Motion. It is only fair, perhaps, that I should refer to the unfavourable opinion of this example expressed by Dr. Whewell (Philosophy of Discovery, chs. 15, 16), who pronounces that 'as an example of the mode of interrogating Nature, it cannot be looked upon

20th Aphorism, as illustrating the theory which he has himself so ably and clearly expounded.

On an impartial investigation, then, of this question [15], I think we must conclude that, while Bacon undoubtedly did not possess any extensive or precise acquaintance with any single branch of science, and while, in some respects, his writings did not keep pace with the discoveries of the day, his range of vision covered an extraordinarily vast sweep of knowledge, and his scientific conceptions, and the suggestions which from time to time he throws out, occasionally shew a marvellous amount of sagacity and penetration. That they were also fertile in the subsequent History of Science, by raising man's hopes of what might be achieved, by stimulating to enquiry, and by actually supplying new points of view in the interpretation of nature, I can hardly entertain any doubt.

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§ 7. BACON'S RELIGIOUS OPINIONS.

Two of the most striking Aphorisms in the First Book of the Novum Organum are the 65th and 89th. In the former, after speaking of the 'corruptio philosophiae ex superstitione et theologia admista,' Bacon goes on to say: 'Pessima enim res est errorum apotheosis, et pro peste intellectus habenda est, si vanis accedat veneratio. Huic autem vanitati nonnulli ex modernis summa levitate ita indulserunt, ut in primo capitulo Geneseos, et in libro Job, et aliis

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otherwise than as a complete failure.' But, though I cannot admit this criticism as other than very exaggerated even as to the mode of enquiry, with regard to the result it is surely a sufficient answer that Bacon did, as a matter of fact, divine the true nature of heat.

[15] It must be understood that I have not attempted to give an exhaustive account either of Bacon's scientific errors or of his scientific claims to recognition. In each case, I have only attempted to select typical examples, though I think I have included nearly all the points of real importance on either side.

Of the invention of the thermometer, ascribed to Bacon by De Vanzelles and Bouillet, I have said nothing, because I think the fact that Bacon, in none of the places where he makes mention of this instrument, advances any claim to its invention, is alone a sufficient reason, if not for positively denying his invention of it, at least for not positively ascribing it to him. Mr. Ellis (in a note on Nov. Org. ii. 13 (38) and Rémusat (pp. 34, 35) agree in thinking that the invention has been ascribed to Bacon without good reason. It is probably due, in the first instance, to Galileo.

Scripturis sacris, philosophiam naturalem fundare conati sint; inter viva quaerentes mortua. Tantoque magis haec vanitas inhibenda venit, et coercenda, quia ex divinorum et humanorum malesana admistione, non solum educitur philosophia phantastica, sed etiam religio haeretica. Itaque salutare admodum est, si mente sobria fidei tantum dentur quae fidei sunt.' In the latter he says, speaking of the causes of the slight progress hitherto made by men in the sciences, 'Neque illud praetermittendum est, quod nacta sit philosophia naturalis per omnes aetates adversarium molestum et difficilem; superstitionem nimirum, et zelum religionis caecum et immoderatum.' And again: 'At in hujusmodi misturis theologiae cum philosophia, ea tantum, quae nunc in philosophia recepta sunt, comprehenduntur; sed nova, licet in melius mutata, tantum non summoventur et exterminantur.' And he sums up as follows: 'At vere rem reputanti, philosophia naturalis, post verbum Dei, certissima superstitionis medicina est; eademque probatissimum fidei alimentum. Itaque merito religioni donatur tanquam fidissima ancilla: cum altera voluntatem Dei, altera potestatem manifestet.'

Now I think that these passages, and the complete separation which he there advocates between theology and science, furnish the best key to Bacon's religious opinions, and, at the same time, afford an explanation of the almost constant disputes which have been carried on nearly from his own times to ours as to what the nature of his religious opinions really was. It is easy to see that a man who penned the above sentences might readily be suspected of harbouring in his mind a still greater mistrust of theological conclusions than he overtly expresses; and it is, at the same time, I think, no less easy to see, if we know anything of the history of opinion, that the maxims expressed might in Bacon's age, when speculations of this kind and the comparison of conclusions arrived at in different branches of knowledge were comparatively rare, be uttered, even by a man of the most religious temperament, in perfect good-faith.

I am myself of opinion not only that the religious side of these Aphorisms expresses Bacon's sincere convictions, but also that he did not materially dissent from the religious teaching on what may be called the fundamental doctrines of Christianity which was generally current in his day.

In order to arrive at an independent opinion on this point, I will ask the reader, who is interested in the question, carefully to compare the following references (which are, of course, far too long to be extracted): Nov. Org. i. 65, 89; De Augmentis, lib. i. (E. and S.,

vol. i. pp. 433–437), iii. 2, iii. 4, ix. throughout; Essays on Unity in Religion, Atheism, and Superstition; and, lastly, Bacon's formal Confession of Faith[16]. Of this last piece, however, it should be stated that it first appeared in the Remains (1648), and that, as it is described in the Harleian MS.[17] as by *Mr*. Bacon, it must have been written before the summer of 1603. Thus, it may possibly (though I have no positive reason for saying that it is so) enter into more minute details of doctrine than Bacon would afterwards have been disposed to do. To the Christian Paradoxes I do not refer, as being now known to have been written by another hand[18].

On carefully considering these and the other passages in which Bacon alludes to religion, or handles religious subjects, the impression left on my mind may be summed up in the following conclusions.

1st. Notwithstanding his admiration for the philosophy of Democritus, and his rejection of Final Causes from the domain of Physics, he retained an unwavering faith in the existence of the Supreme God, the creator and fashioner of the universe. The following well-known sentences from the Essay on Atheism (published, it must be recollected, in its corrected form by Bacon's own authority in 1625, the year before his death) express, I believe, the most sincere convictions of his heart: 'I had rather believe all the fables in the Legend, and the Talmud, and the Alcoran, than that this universal frame is without a mind. And therefore God never wrought miracle to convince atheism, because his ordinary works convince it. It is true, that a little philosophy inclineth man's mind to atheism; but depth in philosophy bringeth men's minds about to religion. For while the mind of man looketh upon second causes scattered, it may sometimes rest in them, and go no further; but when it beholdeth the chain of them, confederate and linked together, it must needs fly to Providence and Deity. Nay, even that school which is most accused of atheism doth most demonstrate religion; that is, the school of Leucippus and

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[16] For which see E. and S., vol. vii. pp. 215–226.

[17] MS. 1893. fo. 1, as referred to by Mr. Spedding.

[18] Namely by Herbert Palmer. The piece is included in the second part of his Memorials of Godliness and Christianity. This fact was discovered by the Rev. Alexander Grosart. Much doubt had previously attached to the piece, in consequence of its not being included in the collections of either Rawley or Tenison, though it appeared in the Remains of 1648. For the curious history of the piece, and the various conjectures about it, see Rémusat, p. 150. note 1, E. and S., vol. vii. p. 289, and, especially, Spedding's Letters and Life, vol. vi. pp. 130, 131.

Democritus and Epicurus. For it is a thousand times more credible, that four mutable elements, and one immutable fifth essence, duly and eternally placed, need no God, than that an army of infinite small portions or seeds unplaced, should have produced this order and beauty without a divine marshal.'

2nd. I cannot question that Bacon also accepted the doctrine of a Divine Providence and a providential order of the world. This, in fact, is implied in the above passage. But the student will do well to read the more explicit statement on this subject, contained in De Augmentis, ii. 11[19]. This passage, which, in substance, occurs also in the Advancement of Learning, must have passed under Bacon's hands and received his final approval as late as 1622 or 1623.

3rd. If we compare De Augmentis, lib. i. (E. and S., vol. i. pp. 483, 484), lib. iv. cap. 1. (p. 585), and lib. iv. cap. 3 (pp. 605, 606), we shall, I think, conclude that, while Bacon had no doubt as to the immortality of the soul, he was, like some of the early fathers, inclined to regard the belief as resting rather on a direct revelation from God than on a necessary, or perhaps even legitimate, conclusion of human reason[20].

4th. With respect to the Christian mysteries, Bacon seems, at least in his earlier years, to have been inclined to trust himself to the guidance of the church; meaning, doubtless, the church as understood by James and Andrewes, which, passing over the intermediate times of Roman superstition, boasted of its now restored connection with the age of the primitive fathers. 'At restat adhuc,' he says, at the beginning of the last Book of the De Augmentis, 'Theologia Sacra, sive Inspirata. Veruntamen si eam tractare pergamus, exeundum nobis foret e Navicula Rationis Humanae, et transeundum in Ecclesiae Navem; quae sola Acu Nautica Divina pollet ad cursum recte dirigendum.' How far Bacon's confidence in the 'ship of the church' was implicit, and without exception, is, I think, somewhat doubtful. For it is a notable fact (which I have not seen elsewhere noticed) that the passage on the nature and attributes of God,

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[19] Cp. also the passage on the proper sphere of Natural Theology in De Augmentis, iii. 2: 'Quocirca, quod sit Deus, quod rerum habenas tractet, quod summe potens, quod sapiens et praescius, quod bonus, quod remunerator, quod vindex, quod adorandus, etiam ex operibus ejus demonstrari et evinci potest.'

[20] It is notable that in the chapter on Natural Theology, quoted in the last note, he does not mention the doctrine of the Immortality of the Soul, though he certainly says nothing to intimate any desire of positively excluding it from the sphere of these enquiries.

including certain statements on the Trinity and the division of the elect and reprobate, which occurs towards the end of the Advancement of Learning, is altogether left out in the De Augmentis, published eighteen years afterwards. Nor, generally, do I notice in Bacon's later works any disposition to enter into details on the more specific doctrines of religion[21].

5th. Connected with this fact, is the very wide toleration which he was evidently ready to concede to dissidents from the more generally received theological opinions. Witness the following passages from the essay Of Unity in Religion: 'Concerning the Bounds of Unity; the true placing of them importeth exceedingly. There appear to be two extremes. For to certain zelants all speech of pacification is odious. *Is it peace, Jehu? What hast thou to do with peace? turn thee behind me.* Peace is not the matter, but following and party. Contrariwise, certain Laodiceans and lukewarm persons think they may accommodate points of religion by middle ways, and taking part of both, and witty reconcilements; as if they would make an arbitrement between God and man. Both these extremes are to be avoided; which will be done, if the league of Christians penned by our Saviour himself were in the two cross clauses thereof soundly and plainly expounded: *He that is not with us is against us;* and again, *He that is not against us is with us;* that is, if the points fundamental and of substance in religion were truly discerned and distinguished from points not merely of faith, but of opinion, order, or good intention. This is a thing may seem to many a matter trivial, and done already. But if it were done less partially, it would be embraced more generally.'

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[21] Macaulay (Essay on Bacon) says, on the whole, very truly: 'He loved to dwell on the power of the Christian religion to effect much that the ancient philosophers could only promise. He loved to consider that religion as the bond of charity, the curb of evil passions, the consolation of the wretched, the support of the timid, the hope of the dying. But controversies on speculative points of theology seem to have engaged scarcely any portion of his attention. In what he wrote on Church Government he showed, as far as he dared, a tolerant and charitable spirit. He troubled himself not at all about Homoousians and Homoiousians, Monothelites and Nestorians. He lived in an age in which disputes on the most subtle points of divinity excited an intense interest throughout Europe, and nowhere more than in England. He was placed in the very thick of the conflict. He was in power at the time of the Synod of Dort, and must for months have been daily deafened with talk about election, reprobation, and final perseverance. Yet we do not remember a line in his works from which it can be inferred that he was either a Calvinist or an Arminian.' I am disposed, however, to think that this description applies with more complete accuracy to Bacon's later than his earlier state of feeling on these subjects.

'Concerning the Means of procuring Unity; men must beware, that in the procuring or muniting of religious unity they do not dissolve and deface the laws of charity and of human society. There be two swords amongst Christians, the spiritual and temporal; and both have their due office and place in the maintenance of religion. But we may not take up the third sword, which is Mahomet's sword, or like unto it; that is, to propagate religion by wars or by sanguinary persecutions to force consciences; except it be in cases of overt scandal, blasphemy, or intermixture of practice against the state; much less to nourish seditions; to authorise conspiracies and rebellions; to put the sword into the people's hands; and the like; tending to the subversion of all government, which is the ordinance of God. For this is but to dash the first table against the second; and so to consider men as Christians, as we forget that they are men. Lucretius the poet, when he beheld the act of Agamemnon, that could endure the sacrificing of his own daughter, exclaimed:

Tantum Relligio potuit suadere malorum:

What would he have said, if he had known of the massacre in France, or the powder treason of England? He would have been seven times more Epicure and atheist than he was. For as the temporal sword is to be drawn with great circumspection in cases of religion; so it is a thing monstrous to put it into the hands of the common people. Let that be left unto the Anabaptists, and other furies. It was great blasphemy when the devil said, *I will ascend and be like the Highest;* but it is greater blasphemy to personate God, and bring him in saying, *I will descend, and be like the prince of darkness:* and what is it better, to make the cause of religion to descend to the cruel and execrable actions of murthering princes, butchery of people, and subversion of states and governments? Surely this is to bring down the Holy Ghost, instead of the likeness of a dove, in the shape of a vulture or raven; and set out of the bark of a Christian church a flag of a bark of pirates and Assassins. Therefore it is most necessary that the church by doctrine and decree, princes by their sword, and all learnings, both Christian and moral, as by their Mercury rod, do damn and send to hell for ever those facts and opinions tending to the support of the same; as hath been already in good part done. Surely in counsels concerning religion, that counsel of the apostle would be prefixed, *Ira hominis non implet justitiam Dei.* And it was a notable observation of a wise father, and no less ingenuously confessed; *that those which held and*

persuaded pressure of consciences, were commonly interessed therein themselves for their own ends.'

Here we seem to have the first note of the key which was afterwards struck with such effect by Chillingworth in his Religion of Protestants, by Jeremy Taylor in his Liberty of Prophesying, and, above all, by Locke in his Letters on Toleration. And, like these writers, Bacon probably did not see the consequences of his own principles. Like them, he would probably have set limits to Toleration, nor am I sure that he would not have set precisely the same limits as Locke, namely, by excluding 'Papists' on the one side and 'Atheists' on the other. As in the case of Locke, too, and, perhaps, of all who advocated Toleration in those days, when the true principles of Political Philosophy were so imperfectly understood, Bacon's zeal against persecution and intolerance arose, probably, in no small measure, from vagueness, uncertainty, or indifference, in his own religious beliefs.

6th. The indifference of which I have just spoken was, I think, certainly one of Bacon's characteristics in relation to religious controversies. It was not merely that he saw the hollowness or absurdity of many of the disputes current in his own day. 'A man that is of judgment and understanding shall sometimes hear ignorant men differ, and know well within himself that those which so differ mean one thing, and yet they themselves would never agree.' 'Men create oppositions which are not; and put them into new terms so fixed, as whereas the meaning ought to govern the term, the term in effect governeth the meaning [22].' A man so acute as Bacon could not help seeing thus far, but his indifference, I think, extended far beyond the range of these mere verbal quibbles and scholastic combats. His indifference was not simply an indifference of the head; it was an indifference of the heart. What he really cared for was the advancement of science, the knowledge of nature, the extension of the kingdom of man [23]. He did not repudiate religion, or even theology; rather, he was a respectful, though silent, worshipper; but, like many another man, he entered the shrine only on occasion, while, at most times, his business lay far away. There was, perhaps, a latent feeling that not much knowledge was to be had in these subjects, numerous and eager as were the workmen engaged in

[22] Essay Of Unity in Religion. These passages do not occur in the Essay Of Religion, published in 1612, and, consequently, first appeared in 1625.

[23] 'Regnum Hominis.' This is the significant title of the Novum Organum.

attempting to extract it; while, in the wide field of nature, the harvest was ready, though the labourers were few. And so Bacon contented himself with working in what appeared to him the more promising field of labour. He sought God in nature, and there he recognised, reverenced, and adored Him. The same God was also to be found in the ark of the Church, and the pages of the Bible; but Bacon's tastes and pursuits lay another way, and hence, though he had no inclination to call in question the leading verities of faith, he received them, always without enthusiasm, and sometimes, even, with apparent indifference.

7th. This last consideration may afford some explanation of the two other points to which I shall call attention. One of these is the evident preference which Bacon accords to Atheism over Superstition. 'It were better to have no opinion of God at all, than such an opinion as is unworthy of him. For the one is unbelief, the other is contumely: and certainly superstition is the reproach of the Deity. Plutarch saith well to that purpose: *Surely* (saith he) *I had rather a great deal men should say there was no such man at all as Plutarch, than that they should say that there was one Plutarch that would eat his children as soon as they were born;* as the poets speak of Saturn. And as the contumely is greater towards God, so the danger is greater towards men. Atheism leaves a man to sense, to philosophy, to natural piety, to laws, to reputation; all which may be guides to an outward moral virtue, though religion were not; but superstition dismounts all these, and erecteth an absolute monarchy in the minds of men. Therefore atheism did never perturb states; for it makes men wary of themselves, as looking no further: and we see the times inclined to atheism (as the time of Augustus Cæsar) were civil times. But superstition hath been the confusion of many states, and bringeth in a new *primum mobile*, that ravisheth all the spheres of government [24].' In this passage, I think, Bacon thoroughly represents the spirit of his time. The recoil from the superstitions of the Church of Rome, and especially from the dangers with which the machinations of that Church seemed to threaten the civil power, had become, in the reformed countries, so intense, and almost so unreasoning, that men could conceive of no opinions equally dangerous either to the well-being of the individual conscience or to the security

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[24] Essay Of Superstition. Cp. a letter to Toby Matthew on his conversion to Romanism (Spedding's Letters and Life, vol. iv. p. 10), where we find pretty nearly the same words as those contained in the beginning of this quotation.

of the state. It required experiences like those of the French Revolution to convince men that the dissolution of the restraints of religion, in minds which from infancy had been accustomed to them, might be even still more desolating in its effects on morals and government. And meanwhile, this view, as stated by Bacon, bore fruit and multiplied. The undiscriminating denunciation of Superstition in the seventeenth century, coupled with the freer mode of enquiry into the fundamentals of religion which marked the close of the period, terminated in results, which, however much he may have contributed to them, he would probably have been among the last to welcome.

8th. The last point which I shall notice is also one which had a great and undoubted effect on subsequent speculation. The interests of Bacon, as we have seen, were in the progress of science. What he, above all things, desired was a clear and unimpeded course for his favourite pursuit. Now he could never forget (or the divines and controversialists of his time would never have allowed him to forget) what he states so emphatically in the Novum Organum [25], 'quod nacta sit Philosophia Naturalis per omnes aetates adversarium molestum et difficilem; superstitionem nimirum, et zelum religionis caecum et immoderatum.' What then so effectual, and what so obvious, as to declare an entire separation between the spheres of Science and Theology, of Reason and Faith? Their admixture had made the one fantastic, and the other heretical. The remedy, therefore, was to put them asunder; to give to reason the things of reason, and to faith the things of faith. Then, the one would declare the Will of God, and the other His Power [26]. Nor was the idea of this truce, I think, suggested solely by the motive of preserving the rights of science. It was in perfect sincerity, I think, that Bacon wrote, 'Concludamus igitur, Theologiam Sacram ex verbo et oraculis Dei, non ex lumine naturae aut rationis dictamine, hauriri debere. Scriptum est enim, *Coeli enarrant gloriam Dei;* at nusquam scriptum invenitur, *Coeli enarrant voluntatem Dei* [27].' The method of the Scholastics had been thoroughly vicious, both in applying Scripture to establish

[25] i. 89. [26] Nov. Org. i. 65, 89.

[27] De Augmentis, lib. ix. (E. and S., vol. i. p. 830). Cp. what he says in the chapter on Natural Theology (iii. 2): 'Verum ex intuitu rerum naturalium atque humanae rationis principiis, de fidei mysteriis vel ratiocinari vel etiam suadere vehementius, aut rursus ea curiosius introspicere et ventilare et de modo mysterii inquirere, haud tutum meo judicio fuerit. *Da Fidei quae Fidei sunt.* * * * * * Quare frustra sudaverit, qui coelestía religionis arcana nostrae rationi adaptare conabitur.'

the principles of science, and in applying reason to establish the principles of religion. Far different was the procedure recommended by Bacon both in the one case and the other. 'Quantum vero ad Illationes, nosse debemus, relinqui nobis usum rationis et ratiocinationis (quoad mysteria) secundarium quendam et respectivum, non primitivum et absolutum. Postquam enim Articuli et Principia Religionis jam in sedibus suis fuerint locata, ita ut a rationis examine penitus eximantur, tum demum conceditur ab illis Illationes derivare ac deducere, secundum analogiam ipsorum. In rebus quidem naturalibus hoc non tenet. Nam et ipsa principia examini subjiciuntur; per Inductionem (inquam) licet minime per Syllogismum; atque eadem illa nullam habent cum ratione repugnantiam, ut ab eodem fonte tum primae propositiones tum mediae deducantur. Aliter fit in Religione; ubi et primae propositiones authypostatae sunt, atque per se subsistentes; et rursus non reguntur ab illa Ratione quae propositiones consequentes deducit[28].' That it did not occur to Bacon to ask on what grounds the authority of Scripture itself reposed, may to us appear strange, but this was not one of the questions which the men of that age were in the habit of putting. I see no reason to doubt that Bacon accepted the authority of Scripture as an ultimate fact, though, as I have already intimated, he may, especially towards the latter period of his life, have felt some hesitation as to the truth or exactitude of some of the dogmatic inferences which had been deduced from its language.

This sharp separation of Religion and Science, Faith and Reason, exercised a considerable influence on Bacon's successors. Hobbes, while he shewed no disposition to restrict scientific discussions, relegated religion altogether to the cognisance of the magistrate. It was the duty of the state to provide a religion for its subjects, and these had nothing to do but to accept it without doubt, or, at least, without any expression of doubt. Thus, the sphere of religion was removed altogether from the arena of discussion, and we seem here to have almost a parody of some of the principles propounded by Bacon. Pascal, though whether he was influenced by the writings of Bacon or not I have no sufficient grounds for determining, attempted to make the divorce between Faith and Reason complete, in the interests of Religion, as, at a later period, Hume did, or pretended to do, in the interests of Philosophy. Locke, though he wrote a treatise on the Reasonableness of Christianity, shews no disposition in his Essay either, on the one

[28] De Augm. Lib. ix. E. and S., vol. i. pp. 832, 833.

hand, to question the authority of the Scriptures and the first truths of Christianity, or, on the other hand, to allow them to exert any influence on his philosophical speculations. Bayle tries to exaggerate the discrepancies, but, not having the robust faith of Bacon or Locke, he seems, with some hesitation, ready to sacrifice the claims of religious belief to the exigencies of human reason. But, however it may have been with particular individuals, I cannot question that the general tendency, predominant, especially in England, till quite recently, to draw a distinct line of demarcation between the spheres of religion, on the one side, and philosophy and science, on the other, and to combine a sincere belief in the traditional teaching of the Bible or the Church with a perfect independence in the sphere of speculation, is due, in very large measure, to the teaching and example of Bacon. Whether this procedure be or be not legitimate, this is not the place to enquire [29].

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§ 8. THE MEANING ATTACHED BY BACON TO THE WORD 'FORM [30].'

What Bacon precisely means by this word 'Form,' is one of the first questions which must occur to every reader of the Novum Organum, and it is probably one of the last difficulties which will

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[29] In writing this section, I have, of course, read carefully the considerable portion of his work which Kuno Fischer devotes to the same subject. But my conclusions, many of which agree with his, had almost all been previously arrived at by an independent study of Bacon's writings.

[30] For the sake of those who are unacquainted, or have only a slight acquaintance, with the philosophy of Aristotle, it is, perhaps, desirable that I should here give a brief account of the Aristotelian distinction of the Four Causes. These are popularly known as the Material, Formal, Final, and Efficient Causes. Their Greek equivalents are respectively: for the Material Cause, *ἡ ὕλη* or *τὸ ἐξ οὗ* or *τὸ ὑποκείμενον*; for the Formal Cause, *τὸ εἶδος* or *ἡ μορφή* or *τὸ τί ἦν εἶναι* or *τὸ τί ἐστι* or *ἡ οὐσία*; for the Final Cause, *τὸ οὗ ἕνεκα* or *τὸ τίνος ἕνεκα* or *τὸ τέλος*; for the Efficient Cause, *τὸ ὅθεν ἡ ἀρχὴ τῆς κινήσεως* or *τὸ ὅθεν ἡ κίνησις* or *τὸ κινοῦν*. Of these, the Formal and Material Cause can only be known in relation to each other; thus, the block of marble, which is matter in relation to the formed statue, itself has form in relation to the quarry from which it was hewn, and this again in relation to the stuff out of which it was formed, and so on, till we come to the *πρώτη ὕλη* or shapeless matter or matter without form, which, however, is a mere mental abstraction, having no actual existence. Nor is matter necessarily body. Thus (Phys. II. 3), letters are the matter of syllables, and the premisses the matter of a syllogism. It is simply that on which form supervenes (*τὸ τίνων ὄντων ἀνάγκη τοῦτο*, sc. the form, *εἶναι*. An. Post. ii. 11); and form supervening on matter brings into existence the finished

be cleared from his path. I was at one time inclined to think that, in various parts of his works, he attached to it two entirely distinct meanings, which may be represented roughly by 'cause' and 'essence,' but, as will appear from the sequel, I am now of opinion that, though the word has undoubtedly various shades of meaning in different places, all these admit of derivation from a single conception. The best course of proceeding, however, will be, first, to collect the more important passages in which he attempts either to define the term, or to state with precision the sense in which he accepts or does not accept the investigation of 'forms' as a legitimate branch of his own philosophy.

The most striking passage of all, perhaps, is that in Nov. Org. i. 51: 'Intellectus humanus fertur ad abstracta propter naturam propriam. * * * * Materia potius considerari debet, et ejus schematismi, et meta-schematismi, atque actus purus, et lex actus sive motus; Formae enim commenta animi humani sunt, nisi libeat leges illas actus Formas appellare.' In strong contrast with this, is the passage in De Augmentis, iii. 4 (E. and S., vol. i. pp. 564–568), where he states 'inventionem Formarum ex omnibus scientiae partibus dignissimam esse quae investigetur, si modo fieri possit ut reperiantur. Ad inventionis possibilitatem vero quod attinet, sunt certe ignavi regionum exploratores, qui ubi nil nisi coelum et pontum vident, terras ultra esse prorsus negant.' This passage (which is far too long to be quoted at length) is well worthy of the student's attention, and should be read with care [31]. I may specially refer to the following

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product, be it the statue, man, life, mind, health, or what not. The efficient cause is that by the instrumentality of which form supervenes upon matter, as, for instance, in the case of the statue, the sculptor, or, in the case of health, the medical art, or, in the case of the universe at large, God or *νοῦς*. The final cause (and it is always assumed by Aristotle that there is one; *οὐδὲν μάτην ἡ φύσις ποιεῖ*) is that for which the object exists, the end it subserves, as, for instance, in the case of a statue, the pleasure or improvement of man, in the case of the bones of an animal, the support of the body and the protection of its softer parts, in the case of the state, the welfare of the citizens, and so on.

The student who requires further information should consult Ueberweg, Zeller, or some other History of Philosophy. He should also read, with special attention, Phys. ii. 3 (repeated in Metaph. iv. (v.) 2), Metaph. i. 3, and An. Post. ii. 11. On the question of the coincidences which sometimes exist amongst these Causes, and other difficulties, I have not entered. Nor do I think it would be of any service to draw out the differences of meaning in these terms as employed by Bacon and as employed by Aristotle. The student, who is even moderately acquainted with both authors, can easily, if he has the curiosity, do this for himself.

[31] The passage is to be found with little variation in the much earlier work, the Advancement of Learning, published in 1605. See bk. ii. (E. and S., vol. iii. pp. 355–357).

points as noteworthy. He speaks of an inveterate opinion, 'Rerum formas essentiales, seu veras differentias, nulla humana inveniri diligentia posse.' Plato, a man of a sublime genius, who saw everything as from a high rock, in his doctrine of Ideas perceived that Forms are the true object of knowledge; 'utcunque sententiae hujus verissimae fructum amiserit, Formas penitus a Materia abstractas, non in Materia determinatas, contemplando et prensando.' 'Quod si diligenter, serio, et sincere, ad actionem et usum oculos convertamus, non difficile erit disquirere, et notitiam assequi, quae sint illae formae quarum cognitio res humanas miris modis locupletare et beare possit.' The forms of substances (except that of man, whose form, according to the scriptural expression, seems to be 'spiraculum vitae') 'ita perplexae sunt et complicatae, ut aut omnino de iis inquirere frustra sit, aut inquisitio earum, qualis esse potest, seponi ad tempus, et postquam formae simplicioris naturae rite exploratae sint et inventae, tum demum institui debeat.' We next have the notion that the forms of simple natures or qualities, such as dense and rare, hot and cold, heavy and light, &c., like the letters of the alphabet, are only few in number, that, consequently, the problem of discovering them is not an impossible one, and that, when discovered, we may, by combination of them, arrive at a knowledge of the 'essences and forms' of all substances. Speaking a little further on of these 'simplices rerum formae,' or 'formae primae classis,' he says, 'licet numero paucae, tamen commensurationibus et co-ordinationibus suis omnem varietatem constituunt.' The efficient cause is distinguished from the form, as being 'nihil aliud quam vehiculum formae.' Lastly, the knowledge of the form frees and vastly enlarges human power: 'Causae enim physicae' (that is, the efficient and material causes) 'novis inventis, in simili materia, lucem et ansam praebent; at qui formam aliquam novit, novit etiam ultimam possibilitatem superinducendi naturam illam in omnigenam materiam, eoque minus inter operandum restringitur et alligatur, vel ad materiae basim, vel ad conditionem efficientis[52].'

Returning to the Novum Organum, we find that, in the second book, Bacon attempts to describe Form by a number of equivalents. Thus, at the very beginning, he says: 'Super datum corpus novam naturam, sive novas naturas generare et superinducere, opus et intentio est humanae potentiae. Datae autem naturae formam, sive

[52] The same ideas occur in, perhaps, a still more striking form in Nov. Org. ii. 3.

differentiam veram, sive naturam naturantem, sive fontem emanationis (ista enim vocabula habemus, quae ad indicationem rei proxime accedunt) invenire, opus et intentio est humanae scientiae.' Again, in ii. 4, he tells us: 'forma vera talis est, ut naturam datam ex fonte aliquo essentiae deducat quae inest pluribus, et notior est naturae (ut loquuntur) quam ipsa forma;' in other words, it is the 'differentia vera.' In ii. 20, ad fin. he calls it the 'definitio vera:' 'Ex Vindemiatione autem ista Prima, Forma sive definitio vera Caloris talis est,' &c. In another place (ii. 13), the form is actually described as 'ipsissima res[33].' Then, there are other passages, where, as in i. 51, an attempt is made to explain it by means of the word 'law.' Thus, in ii. 2, we have the passage: 'Licet enim in natura nihil vere existat praeter corpora individua, edentia actus puros individuos ex lege; in doctrinis tamen, illa ipsa lex, ejusque inquisitio, et inventio, atque explicatio, pro fundamento est tam ad sciendum, quam ad operandum. Eam autem legem, ejusque paragraphos, formarum nomine intelligimus; praesertim cum hoc vocabulum invaluerit, et familiariter occurrat.' Again, in ii. 5, we have the expression 'leges fundamentales et communes, quae constituunt formas.' But, perhaps, the most explicit passage of all is that in ii. 17: 'Nos enim quum de formis loquimur, nil aliud intelligimus, quam leges illas et determinationes actus puri quae naturam aliquam simplicem ordinant et constituunt, ut calorem, lumen, pondus, in omnimoda materia et subjecto susceptibili. Itaque eadem res est forma calidi aut forma luminis, et lex calidi sive lex luminis.'

Now, these various passages admit, I think, of being ranged under two classes, according as the word 'Form' may be replaced by words like essence, differentia, definition, &c., or by words like law, cause, &c.[34] In the first class of passages, we may, perhaps, best arrive at Bacon's meaning by distinguishing the different kinds of attributes which may be predicated of any substance or quality. Leaving out purely accidental attributes, which are sometimes predicable and sometimes not, these may be divided into such as are derived from other attributes, as effects from causes, and those which, so far as we

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[33] 'Cum enim Forma rei sit ipsissima res; neque differat res a Forma, aliter quam differunt apparens et existens, aut exterius et interius, aut in ordine ad hominem et in ordine ad universum.' Introduction to Aph. 13. See my note on the passage.

[34] There is one passage (i. 75), in which the two meanings are brought together: 'Hinc opinio, quod formae sive verae rerum differentiae (quae revera sunt leges actus puri) inventu impossibiles sint, et ultra hominem.'

can ascertain, are independent and underived. The latter are what may be called the essential attributes, and, taken together, constitute, in the most intelligible sense which can be attached to that word, the *essence* of the substance, class, or quality[35]. When we attempt to express the essence in words, we enumerate the essential qualities, or construct its *definition*. But the important or characteristic part of the definition is the *differentia*; for the genus may be regarded as already known before we begin to define, our object being to discover the differentia or differentiae which distinguish the term defined from certain other terms which fall under the same genus. We see, then, how, from the conception of the aggregate of independent and underived (or, as we might call them, *primary*) attributes, we are able to explain alike the expressions of essence, definition, and differentia, whether applied to a class (as, say, man or horse), or to what is ordinarily called a substance (as, say, gold), or to a quality (as, say, heat). It is only to the last of these, however, namely qualities or 'simple natures,' that Bacon regarded his method as, at least immediately, applicable.

Coming to the second class of passages, in which the conception of 'law' predominates, we find that they are founded on the scholastic, or rather Aristotelian, distinction of potentia and actus, δύναμις and ἐνέργεια. As this distinction is explained in the notes on i. 51, I may refer the reader, who is not already acquainted with it, to that place. The 'form' is 'lex actus sive motus,' 'lex illa et determinatio actus puri quae naturam aliquam simplicem ordinat et constituit in omnimoda materia et subjecto susceptibili.' The 'form,' then, according to this mode of representing it, is the law which governs (or, as we should rather say, expresses) the process by which a quality (or body) is developed out of its pre-existing conditions. It may be defined as the law of the development or manifestation or production of any given quality or body. (Cp. Nov. Org. II. 25 ad init.) And, if we take into account the pre-existing conditions as well as the law of their development, we obtain the conception of 'cause' in its fullest extent. We thus see how the word 'form' may be replaced by 'law' or 'cause.'

Now, is it possible to reconcile or bring into any connection these two apparently divergent meanings? The form, we have seen, is, according to the one conception, the aggregate of the primary or underived attributes from which the other attributes are derived, as

[35] For a further explanation of my meaning and for illustrations of what I have said in the text, the student may consult the chapters on Heads of Predicables and Definitions in my Deductive Logic.

effects from causes. According to the other conception, it is the law according to which the phenomenon in question is developed out of pre-existing conditions, or, taking into account the conditions, it is, in brief, its cause. But, practically (and the practical interest is with Bacon, we must recollect, always supreme), these two conceptions may, if we take a sufficiently sanguine view of human power, be regarded as leading to the same result. Given the aggregate of primary and underived attributes, and we are able to produce the phenomenon, or, rather, it follows as a matter of course. Given the pre-existing conditions and the law of their development, and (on the important assumption that we are able to put this law in action, that we possess an 'efficiens' as a 'vehiculum formae') we are ourselves able to produce the effect. Thus, the knowledge of the essence (in the sense which I have attached to that word) and the knowledge of the cause are, for all practical purposes, the same [36]. If, to take Bacon's instances, we know that heat consists in a certain kind of motion, or whiteness in a certain juxtaposition of particles, we are already acquainted with the law of its development or cause of its production. Or, to take Lasalle's instance of 'Form' (which seems to me a very good one), if we are acquainted with Newton's analysis of a white ray of light into the several coloured rays of which it is composed, it is indifferent whether we speak of these rays as constituting (= being the essence of) whiteness, or as producing (= being the cause of) whiteness. And, as substances or concrete bodies were, according to Bacon's conception, 'formae copulatae,' or combinations of certain 'simple natures,' a knowledge of the 'essence' would, in their case also, be equivalent to a knowledge of the 'cause.' So far, indeed, did Bacon carry this idea that he supposed that, if we could ever attain (as he did not despair of attaining) to a knowledge of the various 'simple natures' which constitute substances, we should be able, by superimposing them severally, one on the other, to produce the substance in question. See, for instance, the beginning of the 5th Aphorism of the Second Book of the Novum Organum, which furnishes a good example both of the simplicity which he ascribed to Nature and of the sanguine expectations which he had formed of our ultimate power over its operations.

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[36] To this explanation it might certainly be objected that I am confounding laws of co-existence with laws of succession. But then, I think, it might be replied that we must conceive of the secondary or derived qualities as *following* on the collocation of the primary or underived qualities, even though the time occupied be infinitesimal.

The great difference which Bacon himself conceived as distinguishing his own doctrine of Forms from that of the Schoolmen was that, whereas, with them, the 'Form' simply replaced the thing to be explained by some empty abstraction, with him, the 'Form' was to set forth the several conditions on which the phenomenon was dependent, and thus render possible its artificial production. That this conception, however obscurely and ambiguously it is often stated, is an eminently just and fertile one, cannot be doubted.

The reader, who is acquainted with the logic of Aristotle, will not fail to notice the parallel between Bacon's conception of 'Form,' as including the ideas of essence, definition, and cause, and that class of essential definitions in which the cause of the thing defined is set forth in the definition, as, for instance, *τί δ' ἐστὶ βροντή; ψόφος ἀποσβεννυμένου πυρὸς ἐν νέφεσιν* (An. Post. ii. 10). To know a thing (that is, to know its essence) and to know its cause are frequently stated by Aristotle to be identical. Thus, *τὸ τί ἐστιν εἰδέναι ταὐτό ἐστι καὶ διὰ τί ἐστιν.* An. Post. ii. 2[37].

The reader will find a good account of 'Form' in Mr. Ellis's General Preface to the Philosophical Works of Bacon, sect. 8. My conclusions are in general accordance with his, though I have arrived at them by a somewhat different route.

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§ 9. THE METHOD OF EXCLUSIONS.

Bacon evidently regarded this method as the corner-stone of his system[38]. See, for instance, Nov. Org. i. 69, 105; ii. 15, 16, 19.

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[37] On the Aristotelian doctrine of Definition, which presents several points of interest in connection with what has been said in this section, see the excellent monograph of Rassow, Aristotelis de Notionis Definitione Doctrina, Berlin, 1843. Those who have not access to this work may with advantage consult Grote's Aristotle or the Appendix on Definition in Mansel's Edition of Aldrich.

[38] Mr. Ellis refers to a curious and apt passage in the exposition of the Fable of Cupid (De Principiis atque Originibus, E. and S., vol. iii. pp. 81, 82): 'Idque a parabola ipsa monemur, ubi eleganter fingitur Cupido, ovum Nocte incubante exclusum. * * * * *Aptissime autem refertur illud de ovo Noctis ad demonstrationes per quas Cupido iste in lucem editur. Quae enim per affirmativas concluduntur, videntur partus lucis; quae vero per negativas et exclusiones, ea tanquam a tenebris et nocte exprimuntur et educuntur. Est autem iste Cupido vere ovum exclusum a Nocte; notitia enim ejus (quae omnino haberi potest) procedit per exclusiones et negativas.'

To understand his meaning, those passages should be carefully studied in connection with each other as well as with the various places where he speaks of the discovery of Forms.

The complex substances and operations of nature admitted, he conceived, as we have already seen in the section on 'Forms,' of being broken up into a few 'simple natures,' just as the numerous words of a language are composed of a small number of simple sounds or letters. The first business of science, then, was to ascertain the 'forms' of these simple natures. This might, he supposed, be effected by means of the 'Method of Exclusions.' The number of 'simple natures' being limited, and, as he seems to have thought, at least ultimately ascertainable, if we wish to find with what other nature any given nature is invariably connected (this phrase is mine, not his) either as an effect or as a species, we have nothing to do but to go on ascertaining with what natures it is *not* so connected. And if we can succeed in excluding all but one, it follows that this is the nature of which we are in search. 'Est itaque Inductionis verae opus primum (quatenus ad inveniendas formas) rejectio sive exclusiva naturarum singularum, quae non inveniuntur in aliqua instantia, ubi natura data adest; aut inveniuntur in aliqua instantia, ubi natura data abest; aut inveniuntur in aliqua instantia crescere, cum natura data decrescat; aut decrescere, cum natura data crescat. Tum vero post rejectionem et exclusivam debitis modis factam, secundo loco (tanquam in fundo) manebit (abeuntibus in fumum opinionibus volatilibus) forma affirmativa, solida, et vera, et bene terminata[39].' In the present state of knowledge, however, he does not seem to think this ideal attainable. 'Neque vero ipsa exclusiva ullo modo perfecta est, neque adeo esse potest sub initiis' (ii. 19). Hence the necessity not only of the 'Tables,' but also of the 'praerogativae instantiarum' and other 'aids of the intellect,' in order to complete, as far as may be, the 'Exclusiva,' as well as of some method of clearing up our conceptions of the 'simple natures' (which method he likewise regarded as inductive, though he says nothing further about it[40]. See i. 14, 18). 'Itaque nos, qui nec ignari sumus, nec obliti, quantum opus aggrediamur, (viz. ut faciamus intellectum humanum rebus et naturae parem) nullo modo acquiescimus in his, quae adhuc prae-

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[39] Nov. Org. ii. 16.

[40] I am inclined to think that Bacon supposed the work of clearing up our conceptions and that of establishing true axioms would proceed pari passu, though Mr. Ellis (General Preface, p. 37) is apparently of a different opinion. See my note on ii. 19.

cepimus: sed et rem in ulterius provehimus, et fortiora auxilia in usum intellectus machinamur et ministramus; quae nunc subjungemus [41].'

Now, perhaps, the first remark that occurs to one in considering this method is that it seems to be assumed that every 'simple nature' has some other 'simple nature' which is its form, or part of its form. Thus, heat, which is itself a simple nature, is a species of motion, or, to put the same thing in different words, an effect of motion. Some of the 'simple natures,' then, are genera or causes of the other simple natures. But, if so, there must evidently be some one or more of the 'simple natures' which cannot be brought under any genus or cause. This or these, then, have no 'form [42].'

Another remark, already made by Mr. Ellis [43], is that of the two concomitant natures, or, as we have put it, of the two natures invariably connected, there is nothing to determine which is the Form of the other, except the somewhat vague statement that one, besides being convertible with the other, is a limitation of some 'more general nature:' 'inveniatur natura alia, quae sit cum natura data convertibilis, et tamen sit limitatio naturae notioris, instar generis veri [44].' It might, however, be asked, how are we to ascertain the genus of which the Form is the limitation and the 'natura data' the species? How, for instance, are we to know that heat is a species of motion, rather than motion a species of heat? And still, before we begin to search for the differentia, this preliminary point must be settled. The best solution, it appears to me, of this difficulty is to suppose that Bacon was thinking quite as much of the relation of cause and effect as of that of genus and species, and that the subsequence in thought of the 'limitation' (constituting the species) to the genus which it qualifies should be translated, in order to express his meaning fully, into the subsequence in time of the effect to the cause. The question which of two natures is cause, and which effect, can, of course, always be determined in any individual instance, if we can ascertain which of the two has preceded the other.

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[41] Nov. Org. ii .19.

[42] This, perhaps, may have been the reason why Bacon, in writing the second book of the Novum Organum, changed his example from Motion to Heat. It would have been found very difficult to assign the 'form' of Motion. For this earlier example of his method, 'Filum Labyrinthi, sive Inquisitio Legitima de Motu,' see Ellis and Spedding, vol. iii. pp. 621-640.

[43] General Preface to the Philosophical Works, p. 33.

[44] Nov. Org. ii. 4. Cp. Aph. 15.

A third remark is one which I have frequently had occasion to make in the notes on the early Aphorisms of the Second Book, namely, that the whole of the enquiry into Form, and, consequently, the Method of Exclusions, proceeds on the assumption that every phenomenon has only one cause, that is to say, is due to only one set of conditions. Of the 'simple natures' there is some one, and one only, which, if it could be found, is the 'Form' of the 'natura data.' 'Tum vero post rejectionem et exclusivam debitis modis factam, secundo loco * * * manebit * * * forma affirmativa.' But the same event, as is so often and so justly insisted on by Mr. Mill, whenever he has occasion to speak of what he terms 'Plurality of Causes,' may be due to one set of conditions at one time and to a different set of conditions at another. (On Bacon's neglect of this consideration, see Mill's Logic, bk. v. ch. 3. § 7.) Hence, though it is invariably true that the same cause is always followed by the same effect, the converse proposition that the same effect is always due to the same cause would frequently be misleading. Of Bacon's criteria of a Form, therefore, as well as of the exclusion of a Form, some, as I have pointed out in the notes on Aphs. 15 and 16 of Book ii, are vitiated through his ignoring this circumstance.

I may remark, lastly, that the force of Bacon's argument is much more apparent, as well as really greater, when stated affirmatively than negatively. If the connection between two phenomena or 'natures' satisfies all the requirements of the Inductive Methods (and, on a liberal interpretation, we may regard all these requirements as stated in Nov. Org. ii. 15), we are surely justified, without going through any 'exclusion' of other natures, in affirming a causal relation between them. On the other hand, however large the number of 'natures' which we can succeed in excluding, we can hardly ever be certain, in the present state of knowledge or any which we are likely to attain, that we have excluded all but one. And, even supposing we were able to attain this certainty, how do we know, unless we have some positive evidence, that the remaining nature is the cause or 'form' of the given nature? Might they not both be, so far as our knowledge reaches, ultimate facts of nature, uniformities of coexistence, like Inertia and Gravity[45]? That Bacon should have overlooked this objection to his method is the more remarkable, when we take into account Aph. 48 of Book i, where he

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[45] See my Inductive Logic, 3rd ed., pp. 218, 219; and Bain's Inductive Logic, bk. iii. ch. 3, 'Induction of Co-Existence.'

seems to be warning his readers against the commission of this very error[46].

On the whole, it will be seen that Bacon greatly exaggerated the value of this method, though the elimination of error is undoubtedly a most important step towards the discovery of truth, and though, in the course of his exposition, he enunciates a number of rules and maxims which contain the germ of much which is most valuable in the modern Theory of Induction.

I cannot close this section without bearing my testimony to the excellence of Mr. Ellis's remarks on the subject here discussed. See his 'General Preface to the Philosophical Works,' vol. i. pp. 32–39. What I have said ought not to prevent the student from having recourse to this additional assistance on one of the most obscure topics connected with Bacon's system.

§ 10. BACON'S REJECTION OF FINAL CAUSES IN PHYSICS.

The true key to Bacon's views on the employment of Final Causes is to be found in the De Augmentis, iii. 4. They are there rejected from Physics, but transferred to what Bacon calls 'Metaphysics.' 'Metaphysicae pars secunda est Finalium Causarum inquisitio, quam non ut praetermissam sed ut male collocatam notamus. Solent enim inquiri inter Physica, non inter Metaphysica. Quanquam si ordinis hoc solum vitium esset, non mihi fuerit tanti. Ordo enim ad illustrationem pertinet, neque est ex substantia scientiarum. At haec ordinis inversio defectum insignem peperit, et maximam philosophiae induxit calamitatem. Tractatio enim Causarum Finalium in Physicis inquisitionem Causarum Physicarum expulit et dejecit; effecitque ut homines in istiusmodi speciosis et umbratilibus causis acquiescerent, nec inquisitionem causarum realium et vere Physicarum strenue urgerent; ingenti scientiarum detrimento[47].' He proceeds to give instances, and to speak of Aristotle, Plato, Democritus, &c.,

[46] 'At majore cum pernicie intervenit haec impotentia mentis in inventione causarum: nam cum maxime universalia in natura positiva esse debeant, quemadmodum inveniuntur, neque sunt revera causabilia; tamen intellectus humanus, nescius acquiescere, adhuc appetit notiora.'

[47] E. and S., vol. i. pp. 568, 569.

in a passage which is well worthy of the student's attention. He then continues: 'Neque haec eo dicimus quod Causae illae Finales verae non sint, et inquisitione admodum dignae, in speculationibus Metaphysicae; sed quia, dum in Physicarum Causarum possessiones excurrunt et irruunt, misere eam provinciam depopulantur et vastant. Alioquin, si modo intra terminos suos coerceantur, magnopere hallucinantur quicunque eas Physicis Causis adversari aut repugnare putent.' * * * * * 'Neque vero ista res in dubium vocat Providentiam Divinam, aut ei quicquam derogat, sed potius eandem miris modis confirmat et evehit.' * * * * * 'Adeo ut tantum absit ut Causae Physicae homines a Deo et Providentia abducant, ut contra potius philosophi illi qui in iisdem eruendis occupati fuerunt, nullum exitum rei reperiant nisi postremo ad Deum et Providentiam confugiant.' To these quotations may be added some of the passages quoted or referred to in the section on Bacon's Religious Opinions, especially those in the Essay on Atheism and in the De Augmentis, iii. 2.

The student who has carefully considered these passages will, I think, be able to form a just estimate of the extent to which Bacon did and the extent to which he did not intend to reject the study of Final Causes from philosophy. He spoke, I believe, quite seriously, and not with the slightest intention of employing banter, when he compared the enquiry into Final Causes with a virgin consecrated to God[48]. We may, he conceived, legitimately contemplate the ends and objects of the various parts of nature, their relations to one another, and the harmony of the whole, and so rise to some conception, however faint, of the power and wisdom of Him who framed the Universe. 'Quod sit Deus, quod rerum habenas tractet, quod summe potens, quod sapiens et praescius, quod bonus, * * * * * etiam ex operibus ejus demonstrari et evinci potest[49].' But then this

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[48] 'Nam Causarum Finalium inquisitio sterilis est, et tanquam virgo Deo consecrata nihil parit.' De Augm. iii. 5. 'Nihil parit,' as Mr. Ellis observes in his note on the passage, simply means 'non parit opera.' This will be plain to any one who will consult the context. Bacon is speaking of the divisions of the 'Doctrina Operativa.' The enquiry into Efficient and Material Causes produces Mechanics; that into Formal Causes produces Magic; that into Final Causes 'nihil parit.'

Dugald Stewart (Elements, Ed. Hamilton, Works, vol. iii.) says that this epigrammatic maxim has been, perhaps, oftener quoted, particularly by French writers, than any other sentence in Bacon's works; these quotations, he adds, have generally been made without any reference to the context, and, consequently, with considerable misunderstanding of Bacon's meaning.

[49] De Augm. iii. 2.

enquiry must remain consecrated to the service of God. As soon as it intrudes into the province of Physics, it is attended with no results; nay rather, as it diverts the mind from the enquiry into the efficient and material causes, the proper objects of physics, it becomes positively baneful [50].

Apparently inconsistent, however, with this limitation of the censure on the pursuit of Final Causes are passages such as that in Nov. Org. i. 48, where he seems to condemn them generally, as being 'plane ex natura hominis potius quam universi [51].'

Now, with regard to these passages, I may observe, first, that as the De Augmentis received Bacon's final supervision after the publication of the Novum Organum, and as far the most explicit and elaborate passage on this subject is to be found in that work, we are bound, if there is any contradiction, to accept Bacon's later and more detailed rather than his earlier and more casual utterances [52].

In the second place, even though we may regard the analogy of human actions (which are always directed to some specific end, and that too one which usually admits of being ascertained without much difficulty) as wrongly applied to the processes of nature, it does not follow that there is no plan whatsoever in the operations of nature, or even that such plan may not, at least in its broad outlines, admit of being discovered by us. Of the 'work which God worketh from the beginning to the end,' namely the 'summary law of nature,' Bacon does indeed declare that 'it may fairly be doubted whether man's inquiry can attain to it [53],' but, at the same time, we may attain to a sufficiently clear vision of that work to perceive, at least, the power, the wisdom, and the goodness of the source from which it proceeds, foolish and inadequate as may be our guesses with regard to the details of the scheme. And this, I think, is the answer which Bacon himself would have made to any one who had charged him with inconsistency in his different utterances on this, one of the most

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[50] 'At ex his, Causa Finalis tantum abest ut prosit, ut etiam scientias corrumpat, nisi in hominis actionibus.' Nov. Org. ii. 2. See also the passage quoted above from De Augm. iii. 4.

[51] Cp. Nov. Org. i. 65, ii. 2.

[52] To this it might, perhaps, be objected that the passage in the De Augmentis is little more than a repetition of what appeared in Bacon's earlier work, the Advancement of Learning, which was first published in 1605. But we know alike from the testimony of Rawley and from internal evidence that Bacon thoroughly revised the work, as it was undergoing translation, and, moreover, in this very passage there are several alterations, including the important addition at the end.

[53] De Augm. iii. 4 (E. and S., vol. i. p. 567).

difficult questions which presents itself in the course of human speculation.

It is an entirely distinct question whether Bacon acted rightly in expelling the consideration of Final Causes so completely as he proposed to do from the domain of Physics, and it is certainly a curious commentary on his procedure that, at the very time when he was composing the Novum Organum, Harvey was employing this very mode of reasoning in the famous researches which resulted in the discovery of the Circulation of the Blood [54]. Nor would any one, I presume, now deny that the idea of *function*, which implies so much of the idea of Final Cause as is included in the word *adaptation* as distinct from *design*, is a conception absolutely essential to the successful prosecution of at least one science, that of physiology. And, even in the higher sciences of psychology, ethics, and politics, there are few enquirers who can avoid from time to time asking the question, what purpose does such and such a constituent subserve in the mental, moral, or social economy. In chemistry, mineralogy, and those branches of science to which the word 'physics' is often restricted, such enquiries are much rarer, but I question whether there is any single science, other than mathematical, from which the idea of adaptation can be strictly and consistently excluded. How we are to interpret the fact of adaptation is a different question, and one which by the great mass of scientific enquirers would now be answered in a very different fashion from what ever occurred to any but a few isolated thinkers in previous generations. The limits of this Introduction being necessarily restricted, it is enough here simply to allude to the theory of Evolution, and to works such as those of Mr. Darwin, Mr. Wallace, and Mr. Herbert Spencer. To prevent, however, any misconception of my own opinions, I cannot refrain from repeating here what I have already said in another place, that the main drift of the arguments employed in Natural Theology is not affected by the modern theory of Evolution. If I may be allowed to quote myself, 'I am far from denying that the Argument from Final Causes, if it take sufficient account of the evolution of organisms and their power of adapting themselves to external circumstances, and if it be based on the contemplation of Nature as a whole, instead of on that of indi-

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[54] Harvey began publicly to teach this doctrine in 1619, though his work on the subject was not published till 1628. His discovery set out from observing the action of the valves in the veins of many parts of the body, and enquiring into their purpose, assuming, of course, that they had some purpose or other.

vidual objects, may not admit of being stated in such a form as to occupy once more an important position in any scheme of Natural Theology. Bearing in mind these qualifications, it may be perfectly legitimate to speak, with reference to the universe at large, of design and a designer, whatever may have been the agency, and however mysterious and prolonged the process, by which an intelligent Creator may have worked. Theories of evolution may be so stated as not to impair, but indefinitely to exalt, our ideas of the power, wisdom, and benevolence of the Being in whom Nature had its source [55].'

My conclusion, then, is, in brief, that Bacon did not intend to exclude the employment of the argument from Final Causes in Metaphysics (or, as we should rather say, Natural Theology), while his exclusion of it from the domain of physics was far too rigid and absolute. In his defence, however, it ought to be pleaded that the use of this topic in ancient and mediæval philosophy, as well as in the writings of Bacon's contemporaries, was often arbitrary, fanciful, and absurd to the last degree. 'The handling of final causes' had certainly 'intercepted the severe and diligent inquiry of all real and physical causes,' and it might well be maintained that their temporary expulsion, could it have been effected, would have been a real service to science. As it was, I believe that the protest of Bacon and Descartes, who was as little tolerant as Bacon himself of this mode of explaining physical phenomena [56], exerted a decidedly wholesome influence on the scientific procedure of their successors.

In my Inductive Logic, I have given a large number of instances of the absurd or misplaced employment of this Argument, which, I think, will be quite sufficient to shew the pernicious and misleading

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[55] Inductive Logic, 3rd Ed., p. 336, note.

[56] 'Ita denique nullas unquam rationes circa res naturales, a fine, quem Deus aut natura in iis faciendis sibi proposuit, desumemus; quia non tantum nobis debemus arrogare, ut ejus consiliorum participes nos esse putemus.' De Principiis Philosophiae, i. 28. In the Fourth Meditation, after speaking of the difficulty of penetrating the divine designs, he continues: 'ex hoc satis etiam scio innumerabilia illum posse quorum causas ignorem; atque ob hanc unicam rationem totum illud causarum genus quod a fine peti solet, in rebus Physicis nullum usum habere existimo; non enim absque temeritate me puto posse investigare fines Dei.' It would not be difficult to maintain that Descartes' views, as expressed in these passages, were influenced by those of Bacon.

effect which, at times, it has exercised. To these and to my general criticism of the Argument, I must, for the sake of saving space, now refer the reader [57].

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§ 11. THE CAUSES OF ARISTOTLE'S FAILURE IN HIS PHYSICAL RESEARCHES.

Amongst the various causes which have been assigned for Aristotle's comparative failure in this branch of his philosophy are the neglect of facts (or, as it has been otherwise phrased, his disregard of experience), a partiality for abstract reasoning, a want of distinctness and of appropriateness to the facts in the Ideas he employs, and the absence of verification. Of the first, it may be shewn (as has been abundantly done by Dr. Whewell in his History of the Inductive Sciences and by Mr. G. H. Lewes in his work on Aristotle, and as will be obvious to any one acquainted with Aristotle's physical treatises), that it is very inaccurately stated. Aristotle, especially in his History of Animals, has collected a very large number of facts, though the facts may not always be well selected or precisely described. As to the second charge, not only does it err in vagueness, but it may be met with a plea of justification. 'Abstract reasoning,' provided it be properly conducted, is quite as essential a factor of science, as is the accumulation of facts. The third charge (which is that advanced by Dr. Whewell [58]) is certainly well-grounded, but it specifies, as it appears to me, only one of many causes, while it leaves unanswered the question, 'Why are Aristotle's ideas inappropriate to his facts?', one of the very problems to be solved. Nor does it seem to me that the fourth cause (which is that assigned by Mr. Lewes in his work on Aristotle) supplies an adequate explanation. For what is Verification? It is the confirmation of one mode of proof by another, as, for instance, of induction by deduction, or of deduction by induction. But, though Aristotle's reasoning is undoubtedly often

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[57] See Inductive Logic, 3rd Ed., pp. 336-351. The earliest criticism of Bacon's rejection of Final Causes, which possesses much value or discrimination, is to be found in Dugald Stewart's Elements, part ii. subdivision 1. ch. 4. sect. 6 (Ed. Hamilton, Works, vol. iii. pp. 335-357). Much of what Stewart says would now require to be re-cast, in view of the facts and theory of Evolution. But the student will still find his remarks of considerable interest.

[58] See Dr. Whewell's History of the Inductive Sciences, bk. i. ch. 3. sect. 2.

deficient in this respect, and especially in the confirmation of his *a priori* arguments by an inductive examination of facts, yet surely this is not an exhaustive account of the causes which contributed to render so large a proportion of his physical researches futile.

To me it appears that many circumstances combined to mar his efforts in this department of philosophy. Without attempting a complete enumeration, and without pretending that those here given are always mutually exclusive, I may specify the following:

(1) His observations, though very numerous and often very carefully conducted, were not infrequently inaccurate or insufficient. I may refer for instances to the numerous cases adduced by Mr. Lewes in his Aristotle (see, especially, pp. 272, 3, and p. 332), and by the author of an exceedingly interesting Article on the Historia Animalium in the Quarterly Review, No. 233, which, while it does full justice to Aristotle, also freely points out his demerits. See also my Inductive Logic, 3rd Ed., pp. 276, 7.

(2) Though it cannot be said with truth that Aristotle never tried experiments, still it must be confessed that he did so very rarely. The following interesting examples (interesting mainly because they are so rare) are given by Mr. Lewes. 'He refers to the experiment of tying or removing the right testis of the male, previous to congress, in disproof of the hypothesis that the sexes are derived from the right and left testes. He refers to the experiment of removing the eyes from young birds, to show that these organs are capable of being reproduced, a capability not observed in adult birds. Although he places the seat of motive power in the heart, yet he refers to the experiment of removing the heart from tortoises, after which they still continue for some time to move; and to prove that the nutritive soul is contained in the centre, he refers to the insects whose heads and limbs may be removed without destroying their vitality.' Mr. Lewes adds with regard to the last experiment: 'The fact is incorrectly stated. The separated head will live almost as long as the body; and I have often found the hinder part of a triton live and move for hours after its separation from the body.' See Lewes' Aristotle, pp. 112, 3. I do not recollect any experiments proposed by Aristotle in any branch of natural science other than physiology.

(3) He frequently adopted traditional beliefs or stories, some even which appear to us to be of a ridiculous character, without any further investigation. To say nothing of the doctrine of the Elements, the popular notions about gravity and levity, and the like, I may instance from his physiological works the curious statements about the lion, as,

for example, that it has only one bone in its neck, but no cervical vertebrae (Hist. An. ii. 1 (3)), the story that the hen-partridge is impregnated by hearing the voice or smelling the breath of the male bird (De Gen. Anim. iii. 1 (26, &c.)), and the statement, adopted probably from Herodotus, that the crocodile moves its upper jaw (Hist. An. i. 11 (10) and iii. 7 (4)). For additional instances, see the Article in the Quarterly Review, above referred to. Sometimes, as in the case of the cranium of the dog, which he supposes to consist of a single bone (Hist. An. iii. 7 (3)), it is difficult to say whether the mistake is due to defective observation or to the unsuspecting reception of a popular belief, or, lastly, to over-hasty generalisation.

(4) The fault just noticed was also undoubtedly the cause of many of Aristotle's errors. Though, perhaps, he was not without the conception of scientific induction[59], yet the form of induction which he usually employs is that of Simple Enumeration. And, as the enumeration of instances must, in most cases, necessarily be scanty, he naturally lapsed into the habit of generalising on insufficient data. The *selection* of instances as distinct from their *enumeration* (the point on which Bacon so constantly and emphatically insists) would, doubtless, have done much to transform the philosophy of the time, and to accelerate the progress of science. But it is precisely this difference which distinguishes modern from ancient induction. As I have elsewhere (see Inductive Logic, 3rd Ed., pp. 275, &c.) spoken at some length on this defect in Aristotle's method, I shall not dwell on it in this place. It may be described, from different points of view, either as hasty generalisation, or as the use of Inductio per Enumerationem Simplicem in place of Scientific Induction.

(5) Another most important cause of failure is to be found in Aristotle's vague use of general terms. Words like motion, hot and cold, moist and dry, heavy and light, generation and corruption, natural and unnatural, &c., are employed simply in their popular acceptation, without any attempt to give them a definite and precise meaning. The problems proposed for solution being thus wanting in precision, it is not surprising that the results arrived at are vague and unscientific. Under this head, cp. Herschel on the Study of Natural Philosophy, Part ii. ch. 3, and Whewell's History of the Inductive Sciences, Book i. ch. 2. sect. 2.

(6) Lastly, I may add that Aristotle was often diverted from the study

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[59] On Aristotle's Induction, see some further remarks, with references, at the beginning of the section on 'Anticipations of Bacon's Method and Teaching.'

of facts, and prevented from perceiving the due significance of those which he did observe, by his eagerness to discover illustrations of his favourite metaphysical distinctions, such as δύναμις and ἐνέργεια, the ten categories with their subdivisions, the four causes, the different kinds of motion, and the like. His partiality for assigning the final rather than the efficient causes of phenomena is specially to be noticed under this head, as having often led him to the perversion of facts or to erroneous generalisations. This *a priori* mode of investigation, the disposition to look out for illustrations of preconceived maxims or ideas instead of patiently considering what conclusions the facts lead to, is peculiarly opposed to the Baconian method and the spirit of modern science.

Briefly to sum up, Aristotle's collection of facts was often inadequate either in number or character to form a basis of induction, his method was often unscientific, his ideas were often vague and indistinct, and his fundamental maxims and distinctions were generally preconceived and assumed rather than gathered from experience and reasoning [60].

It should, however, be recollected that scientific ideas, adequate and appropriate to the explanation of scientific facts, are usually the slow growth of time, and occur to men only as the sequel of many unsuccessful efforts. Even had Aristotle's collection of facts been more complete and accurate than it was, they had hardly been known sufficiently long to suggest either to him or others the conceptions which were adequate to connect and explain them. We are not perhaps justified in expecting the master to have effected more than he did. The fault was in the scholars, who, instead of carrying on the master's work, contented themselves with blindly bowing to his authority, and repeating his maxims. This undiscriminating admiration naturally, in its turn, provoked the reaction, often almost equally undiscriminating, of which I proceed to treat in the next section.

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[60] Eucken (quoted by Lange, Geschichte des Materialismus, 2nd Ed., vol. i. p. 135) refers Aristotle's failure in his physical researches almost exclusively to the want of scientific instruments, but, as Lange remarks, the moderns began their work of discovery with almost exactly the same scientific appliances as the ancients, and invented the instruments as they proceeded in their researches.

§ 12. THE REACTION AGAINST THE AUTHORITY OF ARISTOTLE.

The violence with which Bacon attacks the person and philosophy of Aristotle is by no means peculiar to him; an exaggerated reaction against the authority of the Aristotelian philosophy was a common feature of his time and of that immediately preceding it. The exaggerated reverence for an author not unnaturally leads to an exaggerated depreciation of him, and the appeal which men were at one time in the habit of constantly making to the authority of the great philosopher as a final arbiter of all controversy may, at least, excuse, if it does not justify, the virulence and bitterness with which his name was handled by the advocates of a new method and the exponents of a new learning.

I shall not attempt to describe the varying fortunes of Aristotle in the schools of the Middle Ages, the gradual diffusion of his works, the predominant influence which, as a rule, he exercised, or the occasional protests, followed sometimes by authoritative decrees, which, on theological grounds, were directed against that influence[61]. Nor shall I describe the treatment which, as the supposed source of the scholastic dogmas, the Aristotelian philosophy received at the hands of the Reformers, who, with the one exception of Melanchthon, so bitterly, and often so ignorantly, opposed it. As illustrating the position of Bacon, I am concerned solely with the philosophical reaction against the Aristotelian method and doctrine, and this it may be interesting to the reader to see exemplified at some length.

Even so early as the twelfth century, we find John of Salisbury (b. about 1120, d. 1180) thinking it necessary to warn his readers that Aristotle had 'erred in many things.' In the curious and interesting treatise, entitled 'Metalogicus,' he grants, on the one hand, that Aristotle was pre-eminently 'the philosopher,' and, in the art of dialectic at least, excelled all others: 'Sed cum singuli suis meritis splendeant, omnes se Aristotelis adorare vestigia gloriantur, adeo quidem ut commune omnium philosophorum nomen praeeminentia quadam sibi proprium fecerit. Nam et autonomatice, id est excel-

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[61] See, amongst other books, Du Boulay, Historia Universitatis Parisiensis; Jourdain, Recherches critiques sur l'âge et l'origine des traductions latines d'Aristote, &c.; Renan, Averroès et Averroisme; Hauréau, De la Philosophie Scolastique; Stöckl, Geschichte der Philosophie des Mittelalters.

lenter, philosophus appellatur[62].' On the other hand, while recommending the study of Aristotle rather than Boethius, he adds: 'Nec tamen Aristotelem ubique plane aut sensisse, aut dixisse protestor, ut sacrosanctum sit, quidquid scripsit. Nam in pluribus, obtinente ratione et auctoritate fidei, convincitur errasse: siquidem non modo studiosum quemlibet, sed et Deum ipsum prava posse committere asserit. * * * * * * Sunt et multi errores ejus, qui in scripturis tam ethnicis quam fidelibus poterunt inveniri; verum in logica parem habuisse non legitur. Unde sic accipiendus est, ut ad promovendos juvenes ad gravioris philosophiae instituta doctor sit, non morum, sed disceptationum[63].'

In the next century, Roger Bacon (b. 1214, d. 1292 or 4) uses language of a similar purport, shewing at once a discriminating respect for the authority of Aristotle, a consciousness that this authority was liable to be strained, and a determination to claim for himself and his contemporaries the liberty of enquiry and, if need were, even of dissent. 'Nam de famosis philosophus solus Aristoteles cum sua familia vocatus est judicio omnium sapientum, quoniam ipse omnes partes philosophiae digessit secundum possibilitatem sui temporis, sed tamen ad finem sapientiae non pervenit, sicut satis manifestabitur inferius[64].' 'Hic enim praecedentium philosophorum errores evacuavit, et augmentavit philosophiam, aspirans ad ejus complementum, quod habuerint antiqui patriarchae, quamvis non potuit singula perficere. Nam posteriores ipsum in aliquibus correxerunt, et multa ad ejus opera addiderunt, et adhuc addentur usque ad finem mundi; quia nihil est perfectum in humanis inventionibus, ut in prioribus est expositum. Hunc natura firmavit, ut dicit Averroes in 3° de Anima, ut ultimam perfectionem hominis inveniret. Hic omnium philosophorum magnorum testimonio praefertur philosophis, et philosophiae ascribendum est id quod ipse affirmavit; unde nunc temporis autonomatice Philosophus nominatur, in auctoritate philosophiae, sicut Paulus in doctrina sapientiae sacrae[65].' 'Et non credo quod Aristoteles plus scivit quam sciunt aliqui sapientes simul congregati. Non dico quin scivit plura quolibet per se, sed aliquot simul juncti plura facerent quam ipse fecit, si expensas sufficientes

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[62] Metalogicus, lib. ii. cap. 16. Cp. Polycraticus, lib. vii. cap. 6: 'Sicut enim urbs Romam, Maronem poeta exprimit, sic et philosophi nomen circa Aristotelem utentium placito contractum est.'

[63] Metalogicus, lib. iv. cap. 27.

[64] Opus Majus, pars i. cap. 3 (Ed. Jebb, p. 6).

[65] Id. pars ii. cap. 8 (Ed. Jebb, p. 36).

haberent[66].' In another very remarkable passage, strangely misinterpreted by Dr. Jebb, who is implicitly followed by Dr. Whewell[67], Roger Bacon, while praising Aristotle himself as indispensable to the student of philosophy, complains so bitterly of the inaccuracy and obscurity of the translations that he says it would have been better if they had never been made, and, had he power over them, he would cause them all to be burnt. 'De qua causa est perversitas translationis maxime in libris Aristotelis et scientia ejus, quae sunt fundamentum totius studii sapientiae. Quare qui ignorat ejus labores, in vanum laborat et littus arat, nec unquam potest in aliis promoveri. Sic translatae sunt et scientiae communes, ut logica, naturalis philosophia, mathematica, ut nullus mortalis possit aliquid dignum de eis intelligere veraciter, sicut ego expertus sum omnino. * * * * * * Certus igitur sum, quod melius esset Latinis, quod sapientia Aristotelis non esset translata, quam tali obscuritate et perversitate tradita, sicut eis qui ponuntur ibi triginta vel quadraginta annos; et quanto plus laborant, tanto minus sciunt, sicut ego probavi in omnibus qui libris Aristotelis adhaeserunt. Unde dominus Robertus, quondam episcopus Lincolniensis sanctae memoriae, neglexit omnino libros Aristotelis et vias eorum, et per experientiam propriam, et auctores alios, et per alias scientias negotiatus est in sapientialibus Aristotelis; et melius centies milesies scivit et scripsit illa de quibus libri Aristotelis loquuntur, quam in ipsius perversis translationibus capi possunt. * * * * * * Si enim haberem potestatem super libros Aristotelis ego facerem omnes cremari, quia non est nisi temporis amissio studere in illis, et causa erroris et multiplicatio ignorantiae, ultra id quod valeat explicari. Et quoniam labores Aristotelis sunt fundamenta totius sapientiae, ideo nemo potest aestimare quantum dispendium accidit Latinis, quia malas translationes receperunt philosophi[68].'

Passing to the Renaissance, we find a tone of expression very different from the cautious and discriminative criticism of these early writers. Men, who had new theories to propound, had become impatient of the constant appeal to authority, and in their minds

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[66] Opus Tertium, cap. 36 (Ed. Brewer, p. 117).

[67] Both these writers transfer what Bacon says of the translations of Aristotle to the works of Aristotle himself, thus almost grotesquely misrepresenting the sentiments of the author. See Dr. Jebb's Preface to the Opus Majus, and Dr. Whewell's History of the Inductive Sciences, 3rd Ed., vol. i. p. 371.

[68] Compendium Studii, cap. 8 (Brewer's Ed., pp. 468, 9). The whole passage from which these extracts are taken is very curious and well worth reading.

the name of Aristotle was associated with the ideas of inflexible dogma and unreasoning opposition to enquiry. He was for them the dictator, the tyrant of the schools, and, till he was dethroned, there was no hope for any regeneration of science, or even for any opportunity of fair discussion. Nor, considering the slavish deference which had long been paid to the name of Aristotle, can this feeling, however exaggerated and unreasoning the form which it often assumed, be regarded with surprise. It seems to have originated chiefly amongst the Italian 'novellists,' as they are called by Bacon, and to have spread rapidly amongst all who were foremost in the revival either of science or letters. The works of Laurentius Valla, Rodolphus Agricola, H. C. Agrippa, Ludovicus Vivès, Paracelsus, Nizolius, Ramus, Telesius, Patricius, Giordano Bruno, Campanella, M. Aur. Severinus, Nicolaus Cabeus [69], and others, all teem with passages indicative of the reaction against Aristotelianism, and exemplifying in various degrees the intensity of feeling, often passing into a bitterness approximating to personal hatred, with which the attack on his authority was carried on. Of these I proceed to give some instances, which are both interesting in themselves and illustrative of the spirit of violent hostility towards the old learning, and especially towards the name of Aristotle, which is so frequently evinced in the works of Bacon [70].

Laurentius Valla (b. 1406, d. 1457), in the Preface to his books on Dialectic, claims the liberty of dissenting from Aristotle, adducing the example of the older Greek philosophers who had always claimed the liberty of dissenting even from the leader of their own sect: 'Quo minus ferendi sunt recentes peripatetici, qui nullius sectae homini interdicunt libertate ab Aristotele dissentiendi; quasi sophos hic non philosophus, et quasi nemo hoc antea fecerit.' He then quotes a number of Greek and Latin authors who had dissented from Aristotle, and proceeds: 'At caeteri Latini caeteros philosophos pro asophis habent: unum Aristotelem amplectentes. Quidni? cum eum solum cognitum habeant: si modo cognoscere est, non in propria sed in aliena lingua lectitare, ne dicam non sincera. Non solum quia plerique ejus libri corrupte translati sunt, sed etiam quia multa belle dicuntur graece, quae non belle dicuntur latine. Quae

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[69] Much more moderate in their strictures were Cardan and Galileo, while amongst the defenders of Aristotle we may count Pomponatius (b. 1462, d. 1524 or 6) and Caesalpinus (b. 1519, d. 1603).

[70] The rarity of some of these books must be my excuse for making extracts rather than giving references. As an excuse for the length of some of the extracts, I can only plead their interest.

res in plurimos maximosque errores egregia quoque ingenia induxit. Adde huc ignorationem nostrae. Quotus enim quisque post Boetium fuit, qui Latinus dici mereatur et non Barbarus. Nam Avicenna et Averrois plane barbari fuerunt, nostrae linguae prorsus ignari, et graeca vix tincti. * * * * * * Hos ego homines verear? hos ego audiam? vetantes, ne quid in Aristotelem dicam. Hos sibi tantum sumere patiar? quod non ipsis Athenis, quod non omnibus philosophis, quod non cunctis saeculis concederetur. Neque vero mihi videtur tanti ingenii Aristoteles, ut quasi Achilles Herculesve inter heroes, aut Luna inter sidera, nedum Sol sit aestimandus. * * * * * At enim composuit plura quam caeteri Aristoteles. Num protinus et praestantiora?' He then attacks him as a compiler, who did not acknowledge the sources of his compilations. The passage, as it proceeds, furnishes curious evidence of the adoration with which Aristotle was commonly regarded. 'Composuit plura quam caeteri. Esto. Num cuncta quam caeteri melius? Num ita ut nihil alii queant dicere? Num ut pro deo habendus sit? Pudet referre apud quosdam esse morem initiandi discipulos, et jurejurando adigendi, nunquam se Aristoteli repugnaturos: genus hominum superstitiosum atque vecors, et de seipso male meritum: cum se facultate fraudent indagandae veritatis: quos si reprehendere jure optimo possumus, quod hanc sibi legem imposuerint, qua tandem insectatione castigare debemus, si hanc legem in alios transferunt? Quare illis contemptis ac spretis si qua sunt quae quam in Aristotele melius dici possunt, ea tentabo ipse melius pro mea virili dicere: non hominis (quod absit) insimulandi gratia, sed honorandae veritatis.' Throughout the work, he freely expresses his differences from Aristotle in detail, using such phrases as 'ineptissima comparatio,' and the like.

Rodolphus Agricola (b. 1443, d. 1485), who, though a native of the Low Countries, had received his philosophical education in Italy, praises Aristotle generally, but complains of his obscurity, and claims the right of forming an independent judgment[71]. His language is much less incisive than that of Laurentius Valla, but will be read with interest as affording further evidence of the opinions of the time. 'Ego Aristotelem summo ingenio, doctrina, eloquentia, rerum peritia, prudentiaque, et (ut semel dicam) summum quidem hominem, sed hominem tamen fuisse puto: hoc est, quem et latere aliquid potuerit, quique ut non omnia primus invenerit, ita aliis post se invenienda aliqua reliquerit, qui etiam non omnia quae invenerat, crediderit in

[71] See his De Inventione Dialectica, lib. i. Ed. of 1552, pp. 23, 24.

vulgus prodenda et nonnunquam fortasse contradicendi studio, quo maxima fere tentantur ingenia, non tam quid ipse sentiret, quam contra quid alius sensisset, dicendum putaret. Plurima ille recte, sed et alius aliquid non male. Quo justiorem ego veniam credo illis esse oportere, si qui fuerunt, qui putarent, non utique illi tanquam scopulo usquequaque adhaerescendum esse, neque de suis desperarunt ingeniis: cum ingrati possit et inique de parente omnium natura existimantis videri, credere ipsam omnia sua in uno illo partu effundentem munera, reliqua posteritati humani generis in omne aevum sterilem effoetamque manere voluisse.'

In the De Incertitudine et Vanitate Scientiarum (where, however, it is the business of the author to find fault) Henricus Cornelius Agrippa (b. 1486, d. 1535), after enumerating the logical works of Aristotle, proceeds in language which reminds us of some of the Aphorisms of Bacon: 'quae secuti Peripatetici, opinantur nihil stare, aut sciri posse, nisi quod syllogizando probetur per Demonstrationem, eam videlicet, quam depingit Aristoteles, sed tamen nunquam in dogmatibus suis observavit, cum omnes suae argumentationes ex praesuppositis ab eo deducantur, quae secuti omnes isti scientiarum pollicitatores, hactenus nullas aut paucissimas veras demonstrationes dederunt, nedum in naturalibus, sed omnes deducunt illas ex praeacceptis, aut ab suo Aristotele aut abs alio, qui illa prior dixerit, quorum authoritatem servant sibi pro principiis demonstrationis [72].' He then goes on to complain that Aristotle's demonstrations are either circular or proceed from occult and unknown properties. In the preceding chapter (De Rhetorica) the old charge of impiety is renewed against the Aristotelians, while the Platonists are, as subsequently by Bacon, accused of superstition: 'Et qui Aristoteli et Platoni impensius student, fiunt illi quidem superstitiosi, hi vero impii.'

Ludovicus Vivès (b. 1492, d. 1540) was a Spaniard by birth, though he spent the greater part of his life in France, England [73], and Belgium. In his book entitled 'De Causis Corruptarum Artium' he frequently alludes to Aristotle. Generally speaking, he extols him, but enlarges on his great obscurity, rendered still more obscure by the bad literal translations then in vogue. He notes contradictions

[72] Cap. vii. De Dialectica.

[73] He was nominated by Fox, as one of the original members of his new foundation, Corpus Christi College, Oxford. But, during his residence in England, he was thrown into prison by Henry VIII, for having opposed him on the question of the Divorce.

in his philosophy, but allows that these are almost unavoidable. In one place, he offers a curious explanation of Aristotle's obscurity. He had so bitterly attacked his predecessors that he feared retaliation from his successors, and therefore purposely made his language ambiguous, in order to baffle opposition. 'Ea res' (namely Aristotle's misrepresentation of the opinions of the older philosophers) 'non solum veras antiquorum sententias nobis ademit, quae fortassis jactura fuisset tolerabilis, verum, quod est gravius, Aristotelem nobis timidiorem effecit ad eloquendum quae sentiret, reputantem scilicet quod est in mimo: Ab alio expectes, alteri quod feceris[74].' Aristotle's treatment of his predecessors is turned into an argument for subjecting his own opinions to examination. 'Quid Aristoteles ipse, an non superiorum omnium placita convellere est ausus? nobis examinare saltem ac censere nefas erit? praesertim quod, ut Seneca sapienter dicit, qui ante nos ista moverunt, non domini nostri, sed duces sunt. Patet omnibus veritas, nondum est occupata. Multum ex illa etiam futuris relictum est[75].' The obscurity, ambiguity, and subtlety of Aristotle is a theme to which he constantly reverts. 'Sed redeo jam ad ea quae de Aristotelis operibus coeperam dicere. Vicit ille quidem superiores omnes atque etiam posteros, est autem in definiendo vafer et occultus, adeo ut pleraque sint idcirco in ejus philosophia incerta et perplexa, parum etiam vera, dum magis curat, quem in modum reprehensionem excludat, quam ut asserat verum. * * * * Sed enimvero neque haec ipsa Aristotelis volumina potuerunt' [sc. nominales] 'intelligere, primum propter locutionem astrictam, et ex brevitate obscuram, hinc propter intricatas et obliquas sententias, tum etiam ob immodicas subtilitates, quibus Aristoteles plerumque non exacuit ingenia, sed perturbat et frangit, tenebrasque et hallucinationem inducit aciei mentis, dum conatur minutias quasdam tenuissimas ostendere, et inutiles per se, et quae intentionem obtutus ingenii subterfugiant ac frustrentur[76].' More specifically, Vivès attacks the logic of Aristotle in terms which recal to us the language of Bacon, and perhaps still more of Ramus.

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[74] Lib. i. Basle Ed. of 1555, p. 338.

[75] In libros de Disciplinis Praefatio. Id. p. 325. In the context of this passage, there are several sentences which remind us of Bacon. Thus, he says that nature is not effete or exhausted, 'ut nihil prioribus annis simile pariat,' but rather the experience of the past ought to enable us far to outstrip our predecessors. At the same time, he claims no superiority for himself, nor does he aim at founding a sect. 'Neque vero ipse aequari me antiquis illis postulo, sed rationes eorum comparari cum meis.' 'Equidem ut de me uno loquar, nolim quenquam se mihi addicere: nec autor unquam sectae, nec suasor ero, etiam si in mea verba jurandum sit.'

[76] De Causis Corruptarum Artium, lib. v. Basle Edition of 1555, p. 410.

After speaking of the dialectical method of Plato's dialogues, and the germs of logical precepts which are to be found in them, he proceeds: 'Sed indubie Aristoteles eam in artis faciem reduxit, ut et rhetoricam. Caeterum, quod liceat cum bona venia dicere, praeterquam quod more suo obscure, et prolixe, etiam parum apte ad usum vel inveniendi argumenta, vel judicandi argumentationes. Nemo est enim, qui quantumlibet diligenter lecta et excussa universa Aristotelis logica sentiat se instrumentum habere, quo in aliqua ad disserendum materia argumenta in promptu excogitet [77].'

Paracelsus (b. 1493, d. 1541), as might be expected from the eccentricity of his character, attacks Aristotle with more asperity and coarseness of expression than any of the writers already cited. The following extracts will suffice as examples of the tone and manner of his attack:

'Ex Philosophia a primis illico ejus incunabulis muscus excrevit: huic postea annati fungi sunt, ceu glandulae in corpore. Aristoteles et ejus asseclae cum Philosophia idem egerunt, quod feces, quae a vino terram extrahunt. Et spuma, licet quidam eorum, quae olla continet, pessima sit: nihilominus tamen in loco sublimiori obnitat, et inferiora meliora obtegit. Hinc etiam, quia melioris obtecti, aliquem gustum resipit, inter cibos quoque numeratur illa: sed canum tamen solum ac felium. Idem hic de vetere quoque Philosophia censendum est: quae fungos saltem ac spumas tractat, non ipsam, unde enata est, materiam [78].'

'Primum autem nos movet justa compellatio nostrorum in Philosophia antecessorum qui operosis laboribus Generationem hominis descripserunt. Quibus etsi quidem Naturae lex nihil denegavit; illis tamen eadem nihil quoque largita videtur. Quicquid enim tradiderunt, id non (ut nostra Philosophia) ex luce rationis enatum est: sed ex argutiis potius interioris sensus ejus, quem ex nobis ipsis concepimus. Quibus pro responsione hoc reddimus, ipsos ex suo tantum cerebro scripsisse, et non ex experientia aut oculari cognitione. Sola enim experientia et scientia digna est, quae quid in lucem proferat, non vero autodoxia, et experientia praesumta. Acutus phantastes Aristoteles de Generatione monumenta non pauca post se reliquit. Is tamen et in ipsa natura misere seductus et Philosophiae naturalis mire ignarus exsistit. Acutus tamen in opinionibus erroneis, et contra naturam impingentibus idem ipse fuit, et momentis admodum probabilibus

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[77] Id. lib. iii. p. 375.
[78] Paradoxorum tom. ii. Opera Omnia, Geneva, 1658, vol. i. p. 188.

suam sententiam stabilivit, eamque rationibus prudentibus confirmavit, ac sententiis artificiosis et jucundis illustravit. Quae tamen si omnia ita sese praecise in natura haberent quemadmodum blanda ejus verba supponunt; quis clariorem unquam in natura lucem desideraret? Sic et caeteri ipsius asseclae, interpretes et discipuli eidem acumini ac subtilitati studuerunt, ut multis ambagibus ac artificiosis ingeniosisque argumentis suas opiniones munirent et stabilirent: Quae tamen omnia in fundamento naturae nil nisi fumus sunt, ac flos contritus et flaccidus. Nobis autem ita persuasum est, praeter beatitudinem aeternam, hominis nihil uspiam nobilius, aut praestabilius exstare, quam naturam cognovisse, ac ab illa ut a magistra ipsa fundamentum omne Philosophiae didicisse. Hoc ut statuimus: sic contra damnamus argutias ingeniosas quae se Philosophiam jactant, nec tamen quicquam aliud, quam opinio speciosa et suis quasi floribus picta et exornata est [79].'

Nizolius (b. 1498, d. 1566) in his 'Anti-Barbarus Philosophicus sive Philosophia Scholasticorum impugnata [80],' first published in 1553, begins at once with an attack on the received mode of philosophising and the inordinate importance attached to the works of Aristotle. The received philosophy, he says, has only been able to maintain itself through the rudeness of the times and the ignorance of men 'qui quae a quibusdam antiquis et Graecis Scriptoribus, ne dicam nugatoribus, invenerunt tradita et literis consignata, ea omnia prorsus temere et sine ulla consideratione receperunt, receptaque approbaverunt: perinde ac si essent oracula quaedam delphica, aut arcana divinitus revelata, quae nullo pacto falsa esse possent.' Not content with this undiscriminating deference, they have made the Logic of Aristotle as it were the door to all knowledge, and his Physics and Metaphysics the steps, as it were, to the summit of wisdom. 'Quae omnia nos in toto hoc opere usque adeo falsa et a veritate aliena esse sumus ostensuri, ut contra potius, qui per omnia in veritate investiganda sequatur praecepta Pseudophilosophorum, et Aristoteli soli ejusque doctrinae in philosophando sit addictus, is nunquam nec recte philosophari nec perfecte veritatem invenire possit [81].' He recommends, indeed, that the works of Aristotle should be frequently

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[79] Paradoxorum tom. i. Op. Omn. vol. i. p. 148.

[80] The alternative title of this work is 'De veris principiis et vera ratione philosophandi contra Pseudo-Philosophos.' It was republished at Frankfort in 1674, with a preliminary dissertation by Leibnitz.

[81] Anti-Barbarus Philosophicus, Prooemium, Ed. Leibnitz, pp. 1, 2.

read, 'sed cum diligenti consideratione atque judicio,' and praises the 'Ethics, Politics, Œconomics, the Books on Animals, and Rhetorics': 'tamen affirmamus et contendimus non multo pauciora vel falsa, vel inutilia, vel etiam ridicula ab eodem scripta reperiri, ut in majori parte librorum Naturalium, ac pene in totis Dialecticis, et non paucissimis Metaphysicis.' He then applies to Aristotle's writing the proverb: 'Ubi bene, nihil melius; ubi male, nihil pejus [82].' When he comes to detail, his criticisms of Aristotle betray the same kind of impatience and asperity with which we are familiar in the works of Bacon. The following may serve as one specimen out of many: 'Quis nisi mente captus, hoc modo proprium assignaret? Sed Aristoteles, ut librum magnum faceret, nihil praetermittebat, quamvis absurdum et ridiculum [83].' At the end of the treatise [84], there is an unsparing invective against Aristotle, accompanied by an attack on Picus Mirandula and others for confining their criticisms to the Commentators on Aristotle, without having the courage to extend them to Aristotle himself. The chapter concludes with two warnings 'memoriae mandanda, et assidue diligenter cogitanda omnibus, qui recte philosophari cupiunt, quorum unum est, Ubicunque et quotcunque Dialectici Metaphysicique sunt, ibidem et totidem esse capitales veritatis hostes, alterum vero, Quamdiu in scholis Philosophorum regnabit Aristoteles iste Dialecticus et Metaphysicus, tamdiu in eis et falsitatem et barbariem, si non linguae et oris, at certe pectoris et cordis regnaturam.'

Over the remaining names on our list we must pass more lightly. Ramus (b. 1502, or, according to another account, 1515, d. in the Massacre of St. Bartholomew 1572) marks the climax of the reaction against Aristotle. He is said to have selected as the thesis for his Master of Arts' Degree the position that all the dogmas of Aristotle are false: 'Lutetiae Magisterii titulum suscepturus, problema hoc sumpsit; quaecunque ab Aristotele dicta essent, commentitia esse [85].' In this story, however, there is probably some exaggeration. But, whether this be so or not, the life, lectures, and works of Ramus formed one long protest against the ascendency of the Aristotelian philosophy, and especially of the Aristotelian Logic. One or two specimens of his diatribes against Aristotle, taken from the Aristotelicae Animadversiones, will be sufficient to give an idea of the vehemence with which he carried on his attack:

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[82] Lib. i. cap. 1, Ed. Leibnitz, pp. 5, 6.

[83] Lib. iv. cap. 1.

[84] Lib. iv. cap. 8.

[85] Petri Rami Vita ex J. T. Freigio descripta, appended to Milton's Logic.

'Ars dialectica est imago naturalis dialecticae: in commentariis autem Aristotelis nihil est ad naturae monitionem propositum: nihil (si naturae veritatem spectes) non confusum, non perturbatum, non contaminatum, non foedatum: ars igitur dialectica in commentariis Aristotelis nulla est[86].'

'Hic mihi omnes Musae et Charites sunt implorandae, ut publicam pestem, et tot jam saeculis corroboratam atque inveteratam aegrotantibus ostendant: phanaticis quibusdam ingeniis persuadeant, ut se colligant: naturam suam intueantur: dei opt. max. munera, quibus affecti sunt, suspiciant: * * * * * * animadvertant ne nimis ingrata barbaraque impietate divinam munificentiam despiciant, nimiumque stolido dementique furore non perturbatorem tanti boni, sed ereptorem: non hostem humani judicii, sed tortorem, carnificemque diligant. Sic enim verissime profiteri possum, si daemonum omnium conventum aliquem princeps ipse tenebrarum de extinguendo doctrinae hujus lumine ageret, auditaque singulorum sententia statueret, non perniciosius, exitiosius, calamitosius quicquam reperturum, quam ab uno Aristotele repertum est.

Dii talem terris avertite pestem:

Quid est judicium, o domine Aristoteles, o unice naturae fili, o deus amentium? sc. dormit. genera judicii quot sunt? nondum e somno excitatus est. sed fortasse deus iste per sacerdotem, aut interpretem aliquem loquitur. heus Aristotelei sacerdotes, quoniam deus vester dormiens nos hic despicit, quid est judicium? quae sunt judicii genera?'

We see from these quotations, which might be multiplied to almost any extent, that the cautious criticism of the earlier writers has degenerated into mere abuse, and that often of the most exaggerated kind.

Bacon in his sixteenth year (September 1576) was sent by his father into France, in the train of the English Ambassador, Sir Amias Paulet. There he resided, chiefly in Paris, till his father's death in March 1578-9[87]. During these two years and a half, he must have heard much, and heard with curiosity and interest, of the opinions of Ramus, of the revolt against Aristotle, and of the hopes to be entertained from the inauguration of a new method of enquiry and from giving a new direction to scientific study. Hence, it is not

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[86] Lyons Edition of 1545, p. 7.

[87] See Spedding's Life and Letters of Bacon, vol. i. pp. 6-8.

unlikely, as M. Barthelemy Saint-Hilaire[88] suggests, that his sojourn in Paris, where Ramism was then in the air, may have had a considerable influence in determining the philosophical position which he afterwards assumed.

At this time, the spirit of revolt against Aristotle was everywhere in the ascendant. Bernardino Telesio of Cosenza (b. 1509, d. 1588), whom Bacon pronounced the 'best of the novellists,' and to whom he makes constant reference throughout his works, invariably criticises Aristotle with the utmost freedom. The reader who is curious to see the direction which this criticism takes, and the tone in which it is conducted, may refer to the Prooemium to the *two* books 'De Rerum Natura juxta propria principia,' &c., and to the Dedication prefixed to the *nine* books bearing the same title. In the latter he says of the Aristotelian philosophy: 'et sensui, et sibi etiam ipsi, quin et Deo Opt. Max. passim repugnat.' His tone, however, compared with that of Ramus, is unusually moderate and respectful[89].

Far the most systematic of the opponents of the Aristotelian philosophy in general was Patrizzi or Patricius (b. 1529, d. 1597). His Discussiones Peripateticae are throughout, for the most part, a bitter attack on the life, works, and opinions of Aristotle. Thus, he frequently breaks out in invectives such as this: 'Quicunque igitur ex Aristotelis dogmatibus philosophatur, is dialectice philosophatur, non philosophice, non scientifice, non rerum veritatis, sed Aristotelicorum placitorum est amator[90].' And, in another place, after comparing two contradictory passages from Aristotle, he says: 'Qua re quid inconstantius? quid tanti nominis philosopho indignius? Sed licuit sibi quidquid voluit: et tamen, omnia credita a suis sunt oracula, in contrariis dogmatibus permultis fides par illi habita[91].' His reasons for combating the philosophy of Aristotle are given at length in an Appendix, entituled 'Veritatis Studiosis,' at the end of his 'Nova de Universis Philosophia.'

Giordano Bruno (b. about 1550, burnt at Rome 1600) was another of the more prominent opponents of Aristotelianism. He wrote a

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[88] De la Logique d'Aristote, vol. ii. pp. 265, 6.

[89] See, for instance, De Rerum Natura, lib. iii. cap. 1: 'Nihil, si in iis [sc. Aristotelis Sententiis] tractandis plus justo interdum immoremur, mortales nobis, ut ignoscant, sed quod a summo naturae interprete dissentire audeamus et non numinis instar illum veneremur, rogandos esse existimamus: qui si illius dictum audiant, aut factum imitentur,' &c.

[90] Disc. Perip., tom. i. lib. 13, Basle Edition of 1581, p. 170.

[91] Id. tom. iv. lib. 1. p. 373.

special treatise, entituled Acrotismus, seu rationes articulorum physicorum adversus peripateticos Parisiis propositorum. In the Dedication prefixed to this work, he says that he should not have written the book, had he thought that the University of Paris owed more to Aristotle, than Aristotle to it. In the celebrated Dialogue, entituled 'La Cena de le Ceneri,' Bruno states that the most enthusiastic adherents of Aristotle ('who are the enemies of those who are not the friends of Aristotle, who would live and die for Aristotle') are often entirely ignorant of the meaning of even the titles of his works ('i quali non intendono ne anche quel che significano i titoli de libri d'Aristotele'). He adds that the real question which ought to be debated between the Aristotelians and their opponents is not whether a doctrine be old or new, but whether it be true or false [92].

Campanella (b. 1568, d. 1639) was an enthusiastic follower of Telesio, and one of the more outspoken of the anti-Aristotelians. One of his works, published at Naples in 1591, was entituled Philosophia sensibus demonstrata; adversus eos qui proprio arbitratu, non autem sensata duce natura philosophati sunt: cum vera defensione Bernardi Telesii. The Preface to this work, written in 1589, abounds in open or covert attacks on Aristotle. Campanella's objections to the philosophy of Aristotle were based as much on theological as on philosophical grounds. In a work entituled Disputatio in Prologum Instauratarum Scientiarum ad Scholas Christianas, praesertim Parisienses, the reader will find a very curious list of these theological objections.

M. A. Severinus [93] (b. 1580, d. 1656), a junior contemporary of Bacon, and, like Campanella, a follower of Telesius, was mainly a writer of medical works. One of these is inscribed Antiperipatias, hoc est adversus Aristoteleos, de respiratione piscium,' &c. Like Bacon, he attacks Aristotle for his treatment of the older Greek Philosophers. Thus, he quotes with approbation the words of Cabaeus, the last author on our list, when describing Aristotle as 'adeo male meritus de antiquis, dum semper in pejorem sensum interpretatur, ut proinde dignus esset, qui ab omnibus male acciperetur, nec unquam ejus dicta ad bonum sensum traherentur.'

Nicolaus Cabaeus, a Jesuit, in his commentaries on the Meteorologica of Aristotle, published at Rome in 1646, constantly asserts that

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[92] Edition of 1584, pp. 16, 17.

[93] This Severinus must not be confounded with P. Severinus the Dane, of whom Bacon speaks in the Temporis Partus Masculus, in De Augmentis, iii. 4, and probably in Nov. Org. i. 116.

we should follow experience and not Aristotle. But, at the same time, he adopts a far more moderate tone than most of the writers whom I have hitherto noticed. Thus, in the Preface 'Ad Lectorem' he states his position as follows: 'Illud quidem affirmo, longe diversis finibus contineri fidem et scientiam. Si Aristotelem volumus sapientiae ducem, non abnuo: si doctrinae magistrum, non recuso: si sapientiae parentem, agnosco in multis, maximisque rebus, et admiror: si ad illius solum suffragium imus in sententiam, si in illius tantum pronunciatis conquiescimus, et ejus dicta, absque alia probatione, nobis sentiendi norma sunt, non admitto: imo dico, qui sic faciunt longe ab Aristotelis doctrina recedere: qui vult illum esse Philosophum, et illum sapientem, qui rerum causas noverit, non qui alicujus dicta memoriae consecravit.'

These selections, which I have brought down to the time of Bacon himself, will be sufficient to shew the nature and strength of the reaction against the philosophy of Aristotle. From his more moderate critics, or those who complained of the blind submission of his followers rather than of the tone and method of the master himself, such as Cardan and Galileo, I have not thought it necessary to quote.

Bacon's own criticisms, degenerating often into invectives, will be sufficiently illustrated from the Novum Organum and the parallel passages which, from time to time, I shall quote from his other writings.

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§ 13. ANTICIPATIONS OF BACON'S METHOD AND TEACHING.

Taking the main peculiarities of Bacon's method and teaching to have been—(1) the emphasis with which he insisted on the necessity of consulting and collecting facts, of going straight to Nature, of instituting observations and experiments before formulating general propositions; (2) the gradual ascent from propositions or axioms of a lower to those of a higher degree of generality; (3) the selection and comparison of instances in place of the old Inductio per Enumerationem Simplicem; (4) the disregard of Authority, and the restraint of Fancy: we may proceed to enquire how far in these and other less important or more detailed parts of his system, he was anticipated by preceding writers. Now, it must be confessed at once that, in many

of these respects, the method of Bacon is to be found embodied in the teaching and example of Aristotle, and even of Socrates and Plato. Induction of some sort or other, and, consequently, the examination and collection of facts, is as old as human reasoning. This object gave me pleasure or pain yesterday, and, therefore, I will pursue or avoid a similar object to-day; or I compassed my ends in this way yesterday, and, therefore, I will try a similar mode again to-day, are amongst the earliest thoughts which would occur to man. It is, therefore, of course, absurd to represent Bacon as the author or discoverer of Induction. What logicians have done is not to invent forms of reasoning, but to analyse, criticise, and offer rules and cautions for securing the due performance of those which already exist. Hence, it would be utterly superfluous to accumulate early instances of inductive reasoning; as respects my present purpose, it is quite sufficient to refer to the ἐπακτικοὶ λόγοι or παραβολή of Socrates[94], and to give a very brief account of Aristotle's method, so far as it relates to the present question.

To my mind nothing can be clearer than that Aristotle rests all evidence ultimately on the observation of individual facts. See, for instance, Metaph. i. 1, Post. An. ii. 19. And, in accordance with this doctrine, the ultimate major premiss of any train of deductive reasoning must itself rest on an induction from particulars. Ἐκ προγινωσκομένων δὲ πᾶσα διδασκαλία, ὥσπερ καὶ ἐν τοῖς ἀναλυτικοῖς λέγομεν· ἡ μὲν γὰρ δι' ἐπαγωγῆς, ἡ δὲ συλλογισμῷ. Ἡ μὲν δὴ ἐπαγωγὴ ἀρχή ἐστι καὶ τοῦ καθόλου, ὁ δὲ συλλογισμὸς ἐκ τῶν καθόλου. Εἰσὶν ἄρα ἀρχαὶ ἐξ ὧν ὁ συλλογισμὸς, ὧν οὐκ ἔστι συλλογισμός· ἐπαγωγὴ ἄρα. Eth. Nic. vi. 3 (3). Ἀδύνατον δὲ τὰ καθόλου θεωρῆσαι μὴ δι' ἐπαγωγῆς . . . ἐπαχθῆναι δὲ μὴ ἔχοντας αἴσθησιν ἀδύνατον· τῶν γὰρ καθ' ἕκαστον ἡ αἴσθησις. An. Post. i. 18. Unfortunately, Aristotle went no further in his formal analysis of induction than to reduce it to the syllogistic type, and, as an almost necessary consequence of this procedure, he required an exhaustive enumeration of all the instances (Inductio per Enumerationem Simplicem or Inductio Completa). Δεῖ δὲ νοεῖν τὸ Γ τὸ ἐξ ἁπάντων τῶν καθ' ἕκαστον συγκείμενον· ἡ γὰρ ἐπαγωγὴ διὰ πάντων. An. Pr. ii. 23. But, as, in most cases, it was impossible to satisfy this requirement in practice, we find him, as a matter of fact, selecting his instances, and that often with great skill[95], though sometimes, it must be confessed, with much

[94] On this mode of reasoning and on Plato's method of Exclusions, see my note on Nov. Org. bk. i. aph. 105.

[95] Ueberweg (System der Logik) rightly calls attention to De Partibus Animalium, iv. 2, as shewing that Aristotle was aware, in practice, of the importance of

carelessness. (On this and other points connected with Aristotle's method, cp. § 11 of this Introduction). Some of his remarks on the proper examination of facts or theories are characterised by great sagacity. Take, for instance, the passage in Eth. vii. 1 (5): Δεῖ δ', ὥσπερ ἐπὶ τῶν ἄλλων, τιθέντας τὰ φαινόμενα, καὶ πρῶτον διαπορήσαντας, οὕτω δεικνύναι μάλιστα μὲν πάντα τὰ ἔνδοξα περὶ ταῦτα τὰ πάθη, εἰ δὲ μή, τὰ πλεῖστα καὶ κυριώτατα· ἐὰν γὰρ λύηταί τε τὰ δυσχερῆ καὶ καταλείπηται τὰ ἔνδοξα, δεδειγμένον ἂν εἴη ἱκανῶς [96]. In his treatises generally, but especially in the Politics and the Historia Animalium, we find extensive collections of facts; nor, as I have shewn elsewhere [97], did he altogether neglect experiment. That he was impatient, and even jealous, of the authority of others [98], has generally been brought as a charge against him, and, about the time of the Revival of Letters, was frequently adduced as an *argumentum ad hominem* by those who were anxious to throw off the bonds of his own authority.

As the works of Aristotle, and specially his logical works, were constantly being reproduced and commented on during the Middle Ages, it would be easy, though superfluous, to accumulate from mediæval writers passages on the origin of knowledge in the perceptions of the senses (as being, at least, its condition, if not its source), and on the relation of induction to deduction. It will be sufficient, as a specimen, to quote the following passages from the Metalogicus of John of Salisbury (lib. iv. capp. 8, 9), written about 1160: 'Et sic demonstrandi scientiam statuit, ac si sensu corporeo teneatur, quae ratio indubitata sic esse convincit. Communes enim conceptiones a singulorum inductione fidem sortiuntur. Impossibile enim est unversalia speculari, non per inductionem; quoniam, ut ait, quae ex abstractione dicuntur, per inductiones, ignota, nota fiunt. Inducere

having regard to causal connection in framing our generalisations. The chapter is also interesting as affording examples of the 'negative instances' to which Bacon attaches so much importance. At the same time, it is remarkable for the carelessness of observation which it displays.

My friend Mr. J. A. Stewart of Christ Church has drawn my attention to a remarkable correspondence between some of the *loci* in Topics, ii. 10, 11, and the canons of reasoning in modern Inductive Logic. The passage is worth more attention than it has received.

It may here be noticed that Aristotle also recognises an imperfect form of induction, answering to the Analogy of Mr. Mill and recent logicians. This is the παράδειγμα or ἐπαγωγὴ ῥητορική. See An. Pr. ii. 24.

[96] Cp. Eth. Nic. i. 8 (1); Eth. Eud. i. 6.

[97] See § 11 of this Introduction.

[98] The case of Reason versus Authority has never been better or more tersely put than by Aristotle, Eth. Nic. i. 6 (1): ἀμφοῖν γὰρ ὄντοιν φίλοιν, ὅσιον προτιμᾶν τὴν ἀλήθειαν. Hence the proverb: 'Amicus Plato; magis amica veritas.'

autem non habentes sensum, impossibile est. Singularium enim sensus est; nec contingit ipsorum accipere scientiam, neque ex universalibus sine inductione, nec per inductionem sine sensu. Fit ergo ex sensu memoria; ex memoria multorum saepius iterata, experimentum; ab experimentis scientiae aut artis ratio manat. Porro ab arte, quae usu et exercitatione firmata est, provenit facultas exsequendi ea, quae ex arte gerenda sunt. Sic itaque sensus corporis, qui prima vis, aut primum exercitium animae est, omnium artium praejacit fundamenta; et praeexistentem format cognitionem, quae primis principiis viam non modo aperit, sed et parit.' 'Planum autem est hoc diligentius inspicienti per singula. Nam cum sensus, secundum Aristotelem, sit naturalis potentia indicativa rerum, aut omnino non est, aut vix est cognitio, deficiente sensu.'

Fertile, however, as these principles might have been in a different age, it must be confessed that they bore little fruit in the time of which I am speaking. It was only men of rare curiosity or of a singular love of nature, like Albert the Great[99] or our own Roger Bacon, who saw the supreme importance of interrogating facts or of rearing science upon experience. To the latter of these great names I shall devote some little space.

First, however, I may remark, by way of parenthesis, that Dr. Whewell[1] discovers certain resemblances between the mediæval mystic, Richard of St. Victor (died 1173) and Francis Bacon. Of these, the most important is the dictum that 'Physical science ascends from effects to causes, and descends again from causes to effects[2].' This, however, appears to me to be one of those incidental utterances which might easily be made without perceiving, as Bacon undoubtedly did perceive, its scientific value or the practical consequences to which, if properly developed, it would lead.

The comparison of the speculations of Roger Bacon (who wrote towards the end of the thirteenth century) with those of his namesake are specially interesting, and have been made much of by those who deny or depreciate the originality of the latter[3]. The whole spirit of

[99] A good account of the physical speculations of this philosopher will be found in Pouchet, Histoire des Sciences Naturelles au Moyen Age, and of his relation to the Scholastic controversies in Hauréau, De la Philosophie Scolastique, chs. 17–19.

[1] Philosophy of Discovery, pp. 52, 53.

[2] 'Physica est quae causas rerum ex suis effectibus, et effectus ex causis deprehendit.' Tractatus Exceptionum, lib. i. cap. 7. A little above, he says, 'Physica tractat de invisibilibus visibilium causis.'

[3] See, especially, Pouchet, Histoire des Sciences Naturelles au Moyen Age, ou Albert Le Grand, pp. 326–370. I refer to Pouchet as less of a partisan than many other writers, who have handled the same subject.

his works bears, perhaps, a nearer resemblance to those of Francis Bacon than can be found in any intermediate writer, but here, of course, I must confine myself to specific points and to a few typical quotations.

In the Opus Majus, Part vi. capp. 1, 2 (Ed. Jebb, pp. 445, &c.), there is a striking disquisition on the necessity and utility of experimental science. The passage is too long to quote at length, but, amongst other things, he says: 'Sine experientia nihil sufficienter sciri potest. Duo enim sunt modi cognoscendi, scilicet per argumentum et experimentum. Argumentum concludit et facit nos concludere quaestionem, sed non certificat neque removet dubitationem, ut quiescat animus in intuitu veritatis, nisi eam inveniat via experientiae; quia multi habent argumenta ad scibilia, sed quia non habent experientiam, negligunt ea, nec vitant nociva nec persequuntur bona.' And again, 'Qui ergo vult sine demonstratione gaudere de veritatibus rerum, oportet quod experientiae sciat vacare. Nam multa scribunt auctores, et vulgus tenet per argumenta, quae fingit sine experientia, quae sunt omnino falsa.' He then proceeds, on the ground of experience, to refute a number of vulgar errors, such as that the diamond can only be broken by goat's blood, &c. At the beginning of cap. 2, he says: 'Haec scientia experimentalis a vulgo studentium est penitus ignorata.' And a little further on (p. 448): 'Et haec scientia habet tres magnas praerogativas respectu aliarum scientiarum. Una est quod omnium illarum conclusiones nobiles investigat per experientiam. Scientiae enim aliae sciunt sua principia invenire per experimenta, sed conclusiones per argumenta facta ex principiis inventis. Si vero debeant habere experientiam conclusionum suarum particularem et completam, tunc oportet quod habeant per adjutorium istius scientiae nobilis.' This last passage distinctly asserts the use of experience both in establishing the principles of science and in verifying its conclusions.

To the same effect is the teaching of cap. 13 of the Opus Tertium. The following passages remind one of Francis Bacon's conception of Natural Philosophy as the 'mater scientiarum.' 'Sed praeter has scientias est una perfectior omnibus, cui omnes famulantur, et quae omnes miro modo certificat: et haec vocatur scientia experimentalis, quae negligit argumenta, quoniam non certificant, quantumcunque sint fortia, nisi simul adsit experientia conclusionis.' 'Et haec scientia certificat omnia naturalia et artificialia in particulari et in propria disciplina, per experientiam perfectam; non per argumenta, ut scientiae pure speculativae, nec per debiles et imperfectas experientias, ut scientiae operativae. Et ideo haec est domina omnium

scientiarum praecedentium, et finis totius speculationis.' (Ed. Brewer, pp. 43–47.)

Again, another point of contact between the two Bacons is the almost exaggerated importance which they attach to utility as the end of science. 'Caeterum ante omnia,' says Roger Bacon, 'utilitas cujuslibet rei consideranda est.' 'Quapropter oportet quod homo consideret utilitatem scientiarum antequam aggrediatur singulas divisim prosequendo.' 'Et igitur cogitavi in praeambulo tractatu utilitates philosophiae praemittere, ut tunc scientiae, quae videntur nihil valere, quaerantur cum diligentia et fervore. Et certus sum quod aliter non est via ad considerandum scientias philosophiae in particulari et in propria disciplina.' 'Et non est dubium quin quicunque, quantumcunque sit sapiens, resiliret a primo libro geometriae, nisi sciret ejus utilitatem; et sic de aliis scientiis omnibus, ut probavi centies. Qui enim auscultat quod triangulus habet tres angulos aequales duobus rectis angulis, et demonstrationem ejus, si nescit utilitatem, ipse non dabit festucam, immo non dignabitur scire.' (Opus Tertium, capp. 5, 6, Ed. Brewer, pp. 18–22.)

Both writers alike shew their strength, when repudiating the charge of novelty. 'Et si obnixe adhuc tertio objiciatur, quod sancti aliqua redarguunt de his, quae scribo, et Gratianus et alii, respondeo quod nunquam fuit tempus quin ea, quae de novo proponuntur, habeant contradictionem, etiam a sanctis et a bonis viris, et a sapientibus in aliis, licet non in his quae inconvenienter reprobant.' (Opus Tertium, cap. 9. p. 28). In the Opus Majus (cap. 6. p. 9), he quotes several passages from Seneca, to the effect 'quanto juniores tanto perspicaciores, quia juniores posteriores successione temporum ingrediuntur labores priorum,' and then adds: 'Nam semper posteriores addiderunt ad opera priorum, et multa correxerunt, et plura mutaverunt, sicut maxime per Aristotelem patet, qui omnes sententias praecedentium discussit.'

The comprehensive view which both these authors took of the various sciences, and the necessity which they saw of studying them in their mutual relations, constitute other points of resemblance between them, as do also the exalted hopes they entertained from the patient study of nature and its application to the purposes of art.

The four causes of error ('comprehendendae veritatis offendicula,' Opus Majus, ad init., Opus Tertium, cap. 22) are compared with the four 'Idola' of the Novum Organum in a note on Book i. Aph. 38. The resemblance, however, is not very close, and, as I have there argued, following Mr. Ellis and Mr. Spedding, Francis Bacon is not

likely to have seen the Opus Majus. Nor, I may add, is he likely to have been acquainted with any of the works in which remarks such as those above quoted are to be found [4]. The parallelisms, therefore, between the two writers, however close in some cases, are, I believe, accidental.

Having thus dwelt with some minuteness on the anticipations of Bacon's teaching to be found in the works of his almost equally illustrious namesake in the thirteenth century, I may pass more lightly over the intermediate period.

Passing over about two centuries, during which, it may be noticed, the precepts and example of Roger Bacon seem to have had little effect (for the schools were engaged with far different work), we come to that almost universal genius — painter, poet, sculptor, architect, mechanist, mathematician, Leonardo da Vinci (b. 1452, d. 1519) [5]. Speaking of certain unpublished manuscripts by him, now in the Library of the Institute at Paris, Libri (Histoire des Sciences Mathé-

[4] Once, and I believe once only, Bacon refers to his namesake, and then in terms of faint praise. See Temporis Partus Masculus (E. and S., vol. iii. p. 534): 'Siquidem utile genus eorum est, qui de theoriis non admodum solliciti, mechanica quadam subtilitate rerum inventarum extensiones prehendunt; qualis est Bacon.' In the Historia Vitae et Mortis, however, there are traces of his having read Dr. Dee's translation (published in 1618) of Roger Bacon's tract De potestate mirabili Artis et Naturae. He may also have read the treatise De retardandis senectutis accidentibus, which was published in Latin at Oxford in 1590.

[5] Hallam, Libri, Whewell, Brewster, and Rémusat, all refer to J. B. Venturi, Essai sur les Ouvrages Physico-Mathématiques de Leonard de Vinci, Paris, 1799. A copy of this tract, which is, I believe, very rare, exists in the British Museum, but I do not know whether the MSS. referred to in it have ever been published in full. Whewell quotes from Venturi the following striking maxims:

'"Theory is the general, Experiments are the soldiers. The interpreter of the artifices of nature is Experience: she is never deceived. Our judgment sometimes is deceived, because it expects effects which Experience refuses to allow." And again, "We must consult Experience, and vary the circumstances till we have drawn from them general rules; for it is she who furnishes true rules. But of what use, you ask, are these rules; I reply, that they direct us in the researches of nature and the operations of art. They prevent our imposing upon ourselves and others by promising ourselves results which we cannot obtain.

'"In the study of the sciences which depend on Mathematics, those who do not consult nature but authors, are not the children of nature, they are only her grandchildren. She is the true teacher of men of genius. But see the absurdity of men! They turn up their noses at a man who prefers to learn from nature herself rather than from authors who are only her clerks."

'In another place, in reference to a particular case, he says, "Nature begins from the Reason and ends in Experience; but for all that, we must take the opposite course; begin from the Experiment and try to discover the Reason."' Whewell's Philosophy of Discovery, pp. 106, 107.

In Hallam's History of Literature, Part i. ch. 3. sect. 5, to which the student would do well to refer, there is a still fuller account of Venturi's tract.

matiques en Italie, tome 3. p. 30) says: 'Souvent on trouve dans le même feuillet . . . des préceptes qui sembleraient tirés de Bacon, s'ils n'étaient écrits longtemps avant la naissance du chancelier d'Angleterre.' And again (pp. 55, 56): 'Dans ses notes . . . ce qui frappe surtout, c'est la méthode philosophique qu'il a constamment suivie. Un siècle avant Galilée et Bacon, pendant qu'on se bornait généralement à commenter les anciens, Léonard a porté le flambeau de la critique dans toutes les parties de la science, et il a donné les préceptes les plus vrais, les plus justes, les plus philosophiques, pour parvenir à reconnaitre les causes des phénomènes naturels. Brisant le joug de l'autorité, combattant les qualités occultes, il proclama l'expérience comme le seul guide sûr, et il ne s'en écarta jamais. Il répète sans cesse que, pour parvenir à la connaissance des phénomènes naturels et pour en tirer tout le fruit possible, on doit commencer par l'observation, passer à l'expérience, et à l'aide de celle-ci chercher à déterminer la cause, puis formuler une règle et la soumettre au calcul. Souvent il revient à ce précepte et il montre par de nombreuses applications toute l'importance de la philosophie des sciences.'

It is needless to remark that these manuscript notes of Leonardo da Vinci can by no possibility have fallen under the eye of Bacon.

Coming now to writers whom Bacon had read, or may have read, we find H. C. Agrippa (1486–1535), in his De Vanitate Scientiarum (cap. 7, De Dialectica), accusing the Logicians of his time of either assuming their first principles or accepting them simply on authority, 'aut ab suo Aristotele, aut abs alio, qui illa prior dixerit.' But, in the same chapter, Agrippa, after his manner, inveighs also against those sciences which are founded on the perceptions of the senses.

Ludovicus Vivès (1492–1540) has some remarks worthy of Bacon himself on the subject of Authority. See Praefatio in libros de Disciplinis (Basle Ed. of 1555, vol. i. pp. 324, 325). 'Neque enim effoeta est jam vel exhausta natura, ut nihil prioribus annis simile pariat.' 'Quantum enim ad disciplinas percipiendas omnes aditum nobis inventa superiorum saeculorum aperiunt, et experientia tam diuturna, ut appareat posse nos, si modo applicaremus eodem animum, melius in universum pronunciare de rebus vitae et naturae, quam Aristotelem, Platonem, aut quenquam antiquorum.' For more to the same effect, see the last section. Stubbe charges Bacon with having borrowed in the De Augmentis from this author's treatise, De Causis Corruptarum Artium, but no one who compares the two books can regard the debt, if any, as a great one.

The constant appeals to experience made by Paracelsus (1493–1541) are recognised by Bacon himself in the Temporis Partus Masculus (E. and S., vol. iii. p. 538): 'Denique Paracelsum et Severinum [sc. Petrum, 1542–1602], cum tantis clamoribus homines ad experientiae suggestum convocant, praecones mihi exopto.' He goes on, however, to say that the appeal to experience was in itself by no means sufficient to conduct them to truth. 'Quid igitur? Num veritatis compotes isti? Nihilo minus.' And, towards the end of the treatise (p. 539), he adds: 'Ego vero (fili), si te jamjam animo ab idolis non repurgato vertiginosis experientiae ambagibus committerem, nae tu ducem cito desiderares.' Paracelsus (as I have elsewhere noticed) is specially emphatic in his rejection of authority.

Rémusat (pp. 388–390), following De Gerando, bestows what appears to me the most exaggerated praise on a small work, published at Basle in 1558, by Acontio or Contio, entitled 'De Methodo sive recta investigandarum tradendarumque artium ac scientiarum ratione.' It seems to me ridiculous to insinuate, as Rémusat appears to do, that Bacon was under special obligations to a work, from which, indeed, there was little to borrow. The book is, for the time at which it was written, a clear and useful little treatise on the practical applications of Logic to study and teaching, but it discusses the four causes, definition, division, and the like, rather than induction and the kindred topics of observation, experiment, &c. The only part of it which admits of comparison with the Novum Organum is pp. 75–78, Leyden Ed., 1617. Speaking of Division, he says that, before we divide, we ought to know 'totum ipsum, quod dividendum sit. Quamobrem, si forte in promptu non sit, indagare illud opportebit ab aliquorum singularium inspectione.' He then shews how we may arrive at a knowledge of the whole from an examination of particular instances, 'abstrahendo semper illa universa a singularibus.' He proceeds to say that the likenesses of diverse things are the means by which we arrive at our knowledge of the whole: 'quamobrem perscrutari illam similitudinem quam diligentissime in rebus dissimilibus necesse est.' But, surely, this has been a common-place of logicians from the days of Socrates and Plato downwards.

The principal object of this work seems to be to recommend the 'methodus resolutiva' or analytic method, the method of working backwards from the effect to the cause, or the end to the means, in preference to the 'methodus compositiva' or synthetic method.

Telesio (1509–1588), whom he himself calls the 'best of the novellists,' Bacon had no doubt read with great care, and in his works

he could not fail to notice the attacks on Aristotle (referred to in the last section) and the constant appeals to sense and experience. The very title of the first of Telesius' nine books 'De Rerum Natura' is sufficient to shew the spirit in which he writes: 'Mundi Constructionem, Corporumque in eo Contentorum Magnitudinem, Naturamque non ratione, quod antiquioribus factum est, inquirendam, sed sensu percipiendam, et ab ipsis habendam esse rebus.' In the Prooemium to the same work, he speaks, much in the same tone as Bacon does afterwards, of those who 'veluti cum Deo de sapientia contendentes decertantesque, mundi ipsius principia et causas ratione inquirere ausi, et quae non invenerant inventa ea sibi esse existimantes, volentesque veluti suo arbitratu mundum effinxere.' And again: 'non scilicet eo usque sibi homines placere, et eo usque animo efferri oportebat, ut veluti naturae praeeuntes [compare Bacon's "anticipatio naturae"], et Dei ipsius non sapientiam modo, sed potentiam etiam affectantes, ea ipsi rebus darent, quae rebus inesse intuiti non forent, et quae ab ipsis omnino habenda erant rebus.' In opposition to this ambitious method, he declares his own intention of following only sense and nature: 'sensum videlicet nos, et naturam, aliud praeterea nihil sequuti sumus, quae perpetuo sibi ipsi concors, idem semper et eodem agit modo, atque idem semper operatur.' In book viii, where he discusses the nature of knowledge, he lays down, amongst others, the following propositions: 'Scientiarum omnium et geometriae ipsius principia a sensu haberi, vel proxima eorum, quae sensu percepta sunt, similitudine, et conclusiones omnes ex iis pendere' (cap. 4); 'Conclusiones naturales in eo mathematicis praestare, quod hae a signo omnes, illae vero a propriis causis propriisque manant principiis.' (cap. 5.) Here, and elsewhere in this Book, Telesius enunciates the principle of the origin of all knowledge in the perceptions of the senses, at least as distinctly, if not more distinctly, than Bacon himself. With regard to individual doctrines, I shall, from time to time, draw attention in the notes to many points of agreement between Bacon and Telesius, but I am not aware that, as regards method, there is anything more to notice than the general agreement which I have already pointed out. There is, so far as I am aware, no attempt in the works of Telesius to analyse induction, or to give any specific rules for its right conduct.

The origin of knowledge in the perceptions of the senses and the consequent importance of experience seems to have been a commonplace of philosophers in the sixteenth century. Caesalpinus (1519–

1603) the adherent, and Patricius (1529–1597) the opponent of Aristotle, are agreed on this point.

Not to multiply quotations needlessly, I shall pass on to Campanella (1568–1639), whose name is frequently coupled with that of Bacon by the German writers of the seventeenth century, and who was celebrated, in his time, as a disciple of Telesius. In the Preface to one of his works, entituled Philosophia Sensibus Demonstrata, &c., already referred to on p. 84, he says: 'Idcirco, cum ea sit rerum ad Sentientem animam intelligentemque adaequata cognitio, ab ipsis procedens rebus, eo pacto creatis existentibus, dispositisque a summo rerum Conditore, quo pacto esse intelligi debeant; efficitur, ut a rebus ipsis sentitis sint accipiendae rerum origines, quantitates, formae, facultates, et facies, ac mutationes, et quales sunt, tales esse decernantur, minime autem sicut nostra dictat ratio, longe mutabilis ob dissimiles rerum variabilium inspectiones, modosque in intelligente spiritu reservatos. Hinc nos, post assiduam valde quinque annorum lectionem Antiquorum philosophorum, praecipue Peripateticorum et Platonicorum * * * * * * decrevimus rerum naturam ex sensu investigandam esse, cui ipsa talem prompte sese offert, qualis est, et qualem Deus esse voluit.' (p. 1.)

And again, a little further on, he adds: 'Quas ob res Scientiam de rebus esse considerantes, non de verbis, nec de Aristotelis dictis, ejusque intellectu et intentione, ab ipsis rebus capiendam censuimus, et investigavimus. Itaque decrevimus, modum investigandi res componere per viam sensus et experientiae, ubi non de vocibus tractetur, et obscuris dictis, sed de rebus per voces ab ipsis rebus excerptas, non fictas, et quo pacto sint res investigandae ab operationibus, faciebus, similitudinibus, et congruentiis earum.' p. 3.)

From works written by Bacon's contemporaries copious extracts might be made on the now pretty familiar themes of the abuse of authority, and of the necessity of consulting nature and trying experiments for ourselves. See, for instance, Kepler's Introduction to the Astronomia Nova, published in 1609, and Galileo's works, passim [6]. It will be sufficient to close this section with a brief notice of the work of one of Bacon's countrymen, the celebrated William Gilbert, father of the sciences of electricity and magnetism. In the address 'Ad Lectorem Candidum' prefixed to the treatise 'De

[6] It should be noticed, however, that the most famous of Galileo's works, the Dialogo dei Massimi Sistemi, was not published till 1632.

Magnete,' published in 1600, there is much which admits of comparison with some of Bacon's Aphorisms. Thus, he contrasts experiments and demonstrations with probable conjectures and 'vulgo philosophantium placita.' After describing, with much disparagement, the 'tam vastus Librorum Oceanus, quibus studiosorum ingenia perturbantur fatiganturque,' he asks: 'Quid ego huic tam perturbatae reipublicae literariae aliquid ulterius adjungerem, aut juratis in aliorum sententias, aut absurdissimis bonarum artium corruptoribus, literatis idiotis, grammaticis, sophistis, rabulis, et plebeculae perversae, Philosophiam hanc inclytam, et propter inaudita plurima quasi novam, et incredibilem damnandam et maledictis dilacerandam exponerem? Sed vobis tantum fere philosophantibus viris ingenuis, qui non ex libris solum, sed ex rebus ipsis scientiam quaeritis, fundamenta ista magnetica commendavi, novo philosophandi genere. At si ipsis opinionibus et paradoxis assentire aliquibus visum non fuerit, videant tamen experimentorum et inventorum, quibus praecipue floret philosophia omnis, magnam frequentiam: quae multis nostris curis, vigiliis, et impensis eruta et demonstrata sunt. Illis gaudete, et in meliores usus, si poteritis, fruimini. Scio, quemadmodum arduum est vetustis novitatem dare, obsoletis nitorem, obscuris lucem, fastiditis gratiam, dubiis fidem: ita multo magis novis et inauditis, contra omnes omnium opiniones, authoritatem aliquam conciliare et stabilire, difficillimum. Neque illud curamus; paucis enim philosophandum censuimus.' The ancient Greeks he forbears to call to his aid. To Aristotle, Ptolemy, Galen, &c., 'suus semper honos tribuatur.' But our age also has brought to light many things which, had they been alive, they would freely have embraced. He uses the expression 'libere philosophari,' and, throughout, extols experiment. It is needless to add that the body of Gilbert's work furnishes many examples of bold, ingenious, and apposite experiments.

When we pass in review these and similar writers, we see that the origin of knowledge in the perceptions of the senses, as taught by Aristotle, had been a tradition of the schools, which had been constantly repeated with more or less of emphasis and more or less consciousness of its significance; that its corollary, the necessity, for the purposes of science, of careful observation of facts, had, though more fitfully, still repeatedly been asserted, and, amongst Bacon's immediate predecessors and contemporaries, had become almost a common-place of the more liberal and adventurous investigators of nature. Experiment, too, though more rarely, had been warmly recommended in

theory and successfully adopted in practice. The argument from Authority (as we have seen, both in this and the last section) had been combated by many with at least sufficient vehemence, nor had the fancies and arbitrary hypotheses of philosophers escaped the animadversions even of those who were equally ready to give play to their own imagination. But, so far as I can ascertain, no one had yet pronounced himself even on these topics with so much point and force, or in a manner so well calculated to lay hold of the popular sympathy, as Bacon, while, with respect to the fertile conception of a scientific and methodical process of induction, as opposed to that then in vogue, I have found nothing in any previous writer which can properly and fairly be said to be an anticipation of the suggestions so abundantly scattered throughout the Novum Organum. To these conclusions I shall hereafter revert in another section, that on the Present Value of Bacon's Logical Works.

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§ 14. BACON'S INFLUENCE ON PHILOSOPHY AND SCIENCE, INCLUDING THE TESTIMONIES OF EARLY WRITERS TO HIM.

One who claims to be a Reformer of Scientific Method may fairly be expected to exert an influence not on this or that branch of knowledge only, but, though it may be in varying degrees, on all branches of knowledge alike. For, different as may be its applications, the fundamental characteristics of Logical Method are the same in all subjects. And this Bacon clearly saw. 'Etiam dubitabit quispiam, potius quam objiciet, utrum nos de Naturali tantum Philosophia, an etiam de scientiis reliquis, Logicis, Ethicis, Politicis, secundum viam nostram perficiendis loquamur. At nos certe de universis haec quae dicta sunt intelligimus: atque quemadmodum vulgaris logica, quae regit res per Syllogismum, non tantum ad naturales, sed ad omnes scientias pertinet; ita et nostra, quae procedit per Inductionem, omnia complectitur.' (Nov. Org. i. 127.)

We may, therefore, conveniently divide the subject of this section by asking, 1st, what was the influence of Bacon's Reform on Philosophy (under which head I include all enquiries into the grounds, conditions, and character of human knowledge and human practice), and 2nd, what was its influence on Science (a word which I take in its modern

sense, as restricted to enquiries into the constitution and modes of action of corporeal objects).

With respect to the first question, I can only state strongly my own belief that the most characteristic school of English psychologists and moralists, and, through them, a most important school of European philosophy, has been profoundly influenced by the method and speculations of Bacon. The main principle of Locke's Essay, namely that all our ideas are derived from either sensation or reflection, appears to me to be contained in germ in the 1st Aphorism of the Novum Organum, while to the attentive reader there can be no doubt that his whole mode of treating psychological questions is thoroughly imbued with the spirit of Bacon's method. It is true that Locke does not mention Bacon[7], but, as I shall point out hereafter, the frequent citation of authors' names was not a fashion of that time. Though the whole of the Essay might not improperly be regarded as a polemic against the philosophy of Descartes, it is only very seldom that Locke refers to him by name. Again, I think it would be very difficult for any one, after carefully reading the 7th Book of the De Augmentis and after tracing the obvious applications of Bacon's principles and method to the science of conduct, to resist the conclusion that his speculations and, perhaps still more, his method of investigation are, to a large extent, the source of that great school of moral philosophy which, numbering men so widely divergent in many respects as Hobbes and Cumberland, Butler and Bentham, agrees in basing the rules of conduct on an inductive examination of the principles of human nature and the consequences of human actions. English philosophy, or, at least, far the larger portion of it, seems to me to be thoroughly Baconian in its aims, in its spirit, and in its method. In the eyes of many this may be a reproach, but, if it be true as a fact, it will go far towards establishing a conclusion as to the influence of Bacon over, at least, one large department of investigation.

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[7] There is a very probable allusion to Bacon in the discussion on Syllogism, which occurs in the chapter on Reason (bk. iv. ch. 17): 'And therefore Syllogism has been thought more proper for the attaining Victory in Dispute, than for the Discovery or Confirmation of Truth in fair enquiries.' Cp., amongst other passages, Nov. Org. i. 13. 'Assensum itaque constringit, non res.' The next clause, 'And if it be certain that Fallacy can be couched in Syllogisms, as it cannot be denied, it must be something else, and not Syllogism, that must discover them,' corresponds with Bacon's frequent pleas for a new Logic which shall test the 'principia scientiarum' themselves.

Before leaving this branch of our subject, it is only fair to mention one very peculiar circumstance connected with it. Hobbes had, in early life, been Bacon's secretary, but, though he wrote a work expressly on 'Computation or Logic,' there is no mention in it of Induction[8], of the Baconian method, or of Bacon himself. It is, perhaps, still more singular that there is no mention of Bacon in the Epistle Dedicatory to the Elements of Philosophy (Molesworth's Edition, English Works, vol. i. ad init.), where he refers to Galileo, Kepler, Harvey, Gassendi, Mersenne, &c. Bacon's name, in fact, so far as I am aware, occurs only twice in the whole of Hobbes' works, and there without any epithet of praise or blame (see Problemata Physica, Molesworth's Edition, Latin Works, vol. iv. p. 317; Decameron Physiologicum, English Works, vol. vii. p. 112). From the extent of Hobbes' writings and the intimate personal relations which had formerly existed between him and Bacon, I can hardly refer this silence to mere accident. It may have been due to some personal pique, or the abstract character of Hobbes' mind may have rebelled against the concrete and inductive spirit of Bacon's philosophy. For, it may be noticed that there are few writers on moral and political questions, in whose works the historical spirit is more conspicuously absent than in Hobbes.

Rémusat draws attention to the silence of Lord Herbert of Cherbury, but the whole bent of his genius was so different from that of Bacon, that this is hardly surprising.

Spinoza, in a letter written in 1661 (Bruder's Ed., vol. ii. p. 146, Ep. ii), has some interesting remarks on Bacon. Having been asked his opinion on Bacon and Descartes, he objects to them, firstly, 'quod tam longe a cognitione primae causae et origine omnium rerum aberrarint;' secondly, 'quod veram naturam humanae mentis non cognoverint;' thirdly, 'quod veram causam erroris nunquam assecuti sint.' He then proceeds to criticise Bacon's Idola Tribus. In Ep. 42 (p. 270), there is another allusion to Bacon: 'Ad haec intelligendum, saltem quoad methodus exigit, non est opus, naturam mentis per primam ejus causam cognoscere, sed sufficit, mentis sive perceptionum historiolam concinnare modo illo, quo Verulamius docet.'

[8] Rémusat, whose remarks on Hobbes (pp. 405-408) seem to me very just and interesting, says that, to the best of his belief, the word Induction occurs only once in Hobbes' writings. This is in a mathematical controversy with Wallis (Molesworth's Ed., Latin Works, vol. iv. p. 179), where he says in a spirit the very reverse of Baconian: 'Inductio autem demonstratio non est, nisi ubi particularia omnia enumerantur, quod hic est impossibile.'

The second question is, to my mind, much more difficult to answer than the first, though I can entertain no doubt that Bacon has exerted a real and beneficial influence on the subsequent progress of science. The extent of this influence, however, and its precise character are not easy to determine.

The best mode of proceeding, perhaps, is to lay before the reader, in chronological order, the testimonies to Bacon's influence and to the value of his method (the attacks or innuendos of his opponents are noticed elsewhere), and then to attempt briefly to estimate the direction in which his influence was exerted and the value historically, as bearing on the subsequent progress of science, of the rules and maxims which he enforces.

TESTIMONIES TO THE VALUE OF BACON'S METHOD AND TO HIS INFLUENCE ON THE PROGRESS OF SCIENCE.

Passing over the contemporary evidence of Dr. Collins (given in Rawley's life of Bacon), Ben Jonson[9], Sir Henry Wotton[10], the Uni-

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[9] Ben Jonson's Discoveries, Works, vol. vii. p. 100, Whalley's Edition, as quoted by Macvey Napier. I ought to take this opportunity of acknowledging the great service which has been rendered to me in the composition of this section by Mr. Napier's Essay. Rémusat (livre iv. ch. 2) reproduces it to a very large extent.

[10] Reliquiae Wottonianae, 3rd Ed., pp. 298–300. And yet this letter to Bacon is so interesting that I cannot refrain from extracting a portion of it: 'I have your Lordship's Letters dated the 20th of October [1620], and I have withal by the care of my Cousin Mr. Thomas Meawtis, and by your own special favour, three copies of that Work [the Novum Organum], wherewith your Lordship hath done a great and ever-living benefit to all the children of Nature, and to Nature herself, in her utmost extent and latitude: who never before had so noble nor so true an Interpreter, or (as I am readier to style your Lordship) never so inward a Secretary of her Cabinet: But of your said work (which came but this week to my hands) I shall find occasion to speak more hereafter, having yet read only the first Book thereof, and a few Aphorisms of the second. For it is not a banquet, that men may superficially taste, and put up the rest in their pockets; but, in truth, a solid feast, which requireth due mastication. Therefore, when I have once myself perused the whole, I determine to have it read piece by piece at certain hours in my domestic College, as an ancient Author: For I have learned thus much by it already, that we are extremely mistaken in the computation of Antiquity, by searching it backwards, because indeed the first times were the youngest; especially in points of natural discovery and experience. * * * * * I lay a night at Lintz, the Metropolis of the higher Austria. * * * * * There I found Kepler, a man famous in the Sciences, as your Lordship knows, to whom I purpose to convey from hence one of your Books, that he may see we have some of our own that can honour our King, as well as he hath done with his Harmonica.'

Isaac Walton, in his life of George Herbert, borrowing, apparently, the language

versity of Oxford[11], &c., as being liable to the objection that it is merely complimentary or proceeds from persons who had themselves no intimate acquaintance with science[12], I proceed at once to cite Descartes, himself an immediate successor of Bacon, and the originator of a very different school of philosophy:

'J'avois oublié à lire un billet que je viens de trouver en votre lettre, où vous me mandez avoir envoyé ma lettre à M. Mydorga, et que vous désirez savoir un moyen de faire des expériences utiles. A cela je n'ai rien à dire après ce que Verulamius en a écrit, sinon que,' &c. Au. P. Mersenne[13], 1631 (Œuvres de Descartes, Ed. Cousin, vol. vi. p. 182).

'Vous m'avez autrefois mandé que vous connoisiez des gens qui se plaisoient à travailler pour l'avancement des sciences, jusques à vouloir même faire toutes sortes d'expériences à leurs depens: si quelqu'un de cette humeur vouloit entreprendre d'écrire l'histoire des apparences célestes selon la méthode de Verulamius, et que, sans y mettre aucunes raisons ni hypothèse, il nous décrivît exactement le ciel tel qu'il paroît maintenant, quelle situation a chaque étoile fixe au respect de ses voisines * * * * ce seroit un ouvrage qui seroit plus utile au public qu'il ne semble peut-être d'abord, et qui me soulageroit de beaucoup de peine.' Id. 1632, p. 210. In another letter to P. Mersenne (p. 93), Bacon is also mentioned.

These passages shew not only that Descartes entertained a great respect for Bacon, but that he regarded his works as a real contribution to scientific method[14].

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of Wotton, speaks of Bacon as 'the great Secretary of Nature and all learning, Sir Francis Bacon.'

[11] Given in Baconiana, pp. 204–206.

[12] These objections, however, would hardly apply to the evidence which we obtain incidentally from a letter of Bacon himself to Andrewes (E. and S., vol. vi. p. 13), in which he says (in 1622): 'I have received from many parts beyond the seas testimonies touching that work [the Novum Organum], such as beyond which I could not expect at the first in so abstruse an argument.'

[13] Mersenne himself, in his work La Verité des Sciences (published in 1625), has a special chapter on Bacon, in which he maintains against the sceptics that Bacon's system is intended, not to destroy the authority of the senses and the reason, but to discover means for arriving at the knowledge of nature and its effects. The Idols are called the four buttresses (arcs-boutans) of the Organon. Mersenne criticises Bacon's attack on Aristotle, and makes several remarks on his individual experiments, as well as on the theological opinions which are expressed in his works.

[14] In M. Baillet's Life of Descartes (published at Paris in 1691), part i. pp. 147–149, we are told of the regret of Descartes and others at hearing of Bacon's death. 'Cette nouvelle toucha sensiblement ceux qui aspiroient après le retablissement de la véritable Philosophie, et qui scavoient que Bacon travailloit à ce grand dessein

Gassendi (who was, in many respects, a precursor of Locke, and whom that philosopher appears to have carefully studied) gives in his book De Logicae Origine et Varietate, cap. 10, a somewhat elaborate account of the contents of the Novum Organum, while, in cap. 11, he compares it favourably with the Logic of Descartes. In the book De Logicae Fine, cap. 6, he recurs to the subject. It is plain that he sympathises warmly with Bacon's aims and efforts: 'Ausu vere Heroico novam tentare viam est ausus, sperareque fore ut, modo illi strenue diligenterque insistatur, nova tandem eaque perfecta condi haberique Philosophia possit.' Descartes is spoken of as imitating Bacon in the destructive part of his method, and praised accordingly. But, in the constructive parts, their methods diverged as widely as could be: 'Non eandem tamen viam est quam Verulamius ingressus; sed cum Verulamius auxilia a rebus ad perficiendam Intellectus cogitationem petierit, ipse, omni rerum cogitatione ablegata, censuit in ipsa cogitatione satis esse praesidii, ut Intellectus possit vi sua in omnium rerum etiam abstrusissimarum, hoc est non modo corporum, sed Dei etiam ac Animae, notitiam perfectam venire.'

'In another work' (I here quote from Mr. Macvey Napier), 'his valuable account of his celebrated friend Peiresc [contained in vol. v. of Gassendi's works], there is a passage in which Bacon is mentioned in a way particularly deserving of notice in the present discussion. "No man," says Gassendi, speaking of his friend, "made more observations, or caused more to be made, to the end, that at last some notions of natural things, more sound and pure than those commonly received, might be collected; for which reason he admired the genius, and approved the design of that great chancellor of England, Sir Francis Bacon." Now, Peiresc died in 1637, only eleven years after Bacon. But this is not all. He was the first man in France, according to Bailly, who deserved the name of an astronomer; and he, as well as Gassendi (who was also distinguished as an astronomer), was a correspondent, friend, and admirer of Galileo: yet we see that Bacon

depuis plusieurs années.' The author then proceeds to contrast the grandeur of his design with the slenderness of his performance, and, like a true disciple, says that the execution of a design so heroic was reserved for a genius still more extraordinary. Of the actual performance in the Novum Organum he speaks disparagingly. 'Mais ce n'étoit qu'un essay de ses sublimes projets, capable seulement de laisser dans l'esprit de ses lecteurs une idée très-grande de ce qu'il faisoit espérer à la Postérité. Aussi voyons nous qu'il n'y approfondit rien; que les propositions et les axiomes qu'il y avance sont plutôt des avis et des expédiens pour donner des ouvertures à méditer, que des maximes propres à établir des principes.' Bayle, in his meagre account of Bacon, refers to this work.

was considered by both as the great leader of reform in Natural Philosophy.'

Passing over the testimony of Costar (Entretiens de Voiture et de Costar, p. 173, Ed. de Paris, 1654), as cited by Bayle, who also tells us that passages collected from the works of Bacon were used by Costar as the foundation of his Common-Place Book, we come to the curious little book, entitled Relation d'un Voyage en Angleterre, by M. Sorbière (Paris 1664, Cologne 1666).

M. Sorbière (whose account of England is not altogether flattering) says: 'De tout temps l'Angleterre a produit d'excellents esprits, qui se sont pleus à l'estude des choses naturelles; et quand elle n'auroit donné à cette science que Gilbert, Harvaeus, et Bacon, elle auroit dequoy le disputer à la France, et à l'Italie, qui nous ont donné Galilée, Descartes, et Gassendi. Mais à dire le vray, Bacon le Chancellier l'a emporté par dessus tous les autres en grandeur de dessein, et en cette docte et judicieuse tablature qu'il nous a laissée, pour reduire utilement en pratique, et tirer hors des disputes de l'Escole, ce que l'on a de connoissances de la Nature; afin de les appliquer à la méchanique, et en applanir les difficultez que l'on rencontre dans la vie. Ce grand homme est sans doute celuy qui a le plus puissamment solicité les interests de la physique, et excité le monde à faire des expériences' (pp. 63, 64 of Cologne Ed.).

As Mr. Napier, to whom I am indebted for the reference to Sorbière, though he only quotes a small portion of the passage, justly says: This testimony 'is entitled to greater consideration from Sorbière having for some time acted as Secretary of one of those associations of Parisian philosophers in which the Academy of Sciences had its origin.'

In the Journal des Savans (March 8, 1666), there is a very interesting notice of the Frankfort Edition of Bacon's works. The writer begins by saying: 'On peut dire que ce grand Chancellier est un de ceux qui ont le plus contribué à l'avancement des sciences. Car reconnaissant que les Anciens nous les ont laissées très-imparfaites et que les modernes n'y ont pas fait de grands progrez; il a composé deux livres pour enseigner par quels moyens on les peut perfectionner.' Speaking of the Novum Organum, he says: 'Il enseigne une Logique nouvelle, dont le principal but est de montrer la manière de faire une bonne Induction, comme la fin principale de la Logique d'Aristote est de faire un bon syllogisme. Cet Ouvrage est excellent, et cet Auteur l'a toujours consideré comme son chef d'œuvre: on dit même qu'il y a travaillé dix-huit ans avant que de le publier.'

Jean Baptiste Du Hamel, the well-known author of the Philosophia Vetus et Nova, and the first Secretary of the Academy of Sciences, in his work De Mente Humana, published in 1672, gives a long account of the Baconian method (lib. iii. capp. 7–9), and, in speaking of Induction, says: 'Verulamius primus hoc argumentum tractavit uberrime,' 'Hoc argumentationis genus a Verulamio tractatum uberrime et ab aliis fere neglectum.' It is plain, therefore, that he regarded Bacon as virtually the author of the Inductive or Experimental Method.

Bayle (whose Dictionary was first published in 1697) says little of Bacon, though, as Mr. Napier points out, he says nothing at all, in the shape of a separate article, of either Galileo or Descartes. But the meagreness of his account is no proof of disparagement. For he calls Bacon 'un des plus grans Esprits de son siècle, et l'un de ceux qui connurent le plus doctement l'imperfection où étoit la Philosophie.' He adds: 'Il travailla fortement aux moiens d'y remédier, et il forma de très-beaux plans de reformation. Le public recut favorablement ses Ouvrages.'

This evidence (which, I believe, might be greatly extended [15]) is sufficient to shew that Bacon's name was, at this period, well known in France, and that his merits were recognised by some of the foremost men in philosophy and science. So inaccurate is the statement of Montucla [16], accepted by Dugald Stewart, and since frequently repeated, that the celebrity of Bacon's writings in France hardly dates back beyond the appearance of the Encyclopédie.

It is unquestionable, however, that the patronage of Voltaire and the Encyclopedists did much to extend the study of Bacon's writings, besides producing a considerable controversy as to his true meaning on many questions of philosophy and theology (see section on the Bibliography of the Novum Organum). Voltaire devoted to Bacon the twelfth of his Lettres sur les Anglois (1728–1730), and directed special

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[15] Thus Malebranche, in the Recherche de la Vérité (the first volume of which was published in 1674), livre ii. 2me partie, ch. 2, quotes from the 'Chancelier Bacon,' 'ces paroles fort judicieuses:' 'omnes perceptiones tam sensus quam mentis sunt ex analogia hominis,' &c. See Nov. Org. i. 41.

[16] Histoire des Mathématiques, Préface, p. ix. (1st Ed.): 'les écrits du Chancelier Bacon, dont la célébrité en France n'a guere pour date que celle de l'Encyclopédie.' It may here be mentioned that a French translation of the De Augmentis appeared in Paris in 1624, the very year after the first publication of the work, and another in 1632. On an early MS. translation of the Novum Organum, which exists in the Bibliothèque Nationale, see a note on the last section of this Introduction.

attention to the Novum Organum: 'Le plus singulier, et le meilleur de ses ouvrages, est celui qui est aujourdhui le moins lu, et le plus util; je veux parler de son *Novum Scientiarum Organum.* C'est l'échafaut avec lequel on a bâti la nouvelle Philosophie, et quand cet édifice a été élevé, au moins en partie, l'échafaut n'a plus été d'aucun usage.'

'Le Chancelier Bacon ne connoissoit pas encore la nature, mais il scavoit et indiquoit tous les chemins qui menent à elle. Il avoit méprisé de bonne heure ce que les Universités appelloient la Philosophie, et il faisoit tout ce qui dépendoit de lui, afin que ces compagnies instituées pour la perfection de la raison humaine, ne continuâssent pas de la gâter par leurs quiddités, leurs horreurs du vuide, leurs formes substancielles, et tous ces mots impertinens, que non seulement l'ignorance rendoit respectables mais qu'un mélange ridicule avec la religion avoit rendu sacrés.'

'Il est le Père de la Philosophie expérimentale. * * * * En un mot, personne avant le Chancelier Bacon n'avoit connu, la Philosophie expérimentale, et de toutes les épreuves physiques qu'on a faites depuis lui, il n'y en a presque pas une qui ne soit indiquée dans son livre. Il en avoit fait lui-même plusieurs. * * * * Mais ce qui m'a le plus surpris, c'a été de voir dans son livre, en termes exprès, cette Attraction nouvelle dont M. Newton passe pour l'inventeur.'

In the Dictionnaire Philosophique, Art. Bacon, this letter is reproduced, with additions on Attraction, the Article beginning: 'Le plus grand service peut-être que François Bacon ait rendu à la philosophie a été de deviner l'attraction.' Though to some extent deserved, Voltaire's praise on this particular point is, as the readers of the Novum Organum will easily discover for themselves, greatly exaggerated.

Condillac, in the Introduction to his Essai sur l'Origine des Connaissances Humaines (1746), singles out Bacon as, perhaps, the first who had perceived that all our knowledge has its origin in sense (a proposition which, in this unqualified form, Bacon would probably not have accepted). This principle is, he proceeds, 'le fondement d'un ouvrage dans lequel il donne d'excellens conseils pour l'avancement des sciences.' Towards the end of the Essay (2me Partie, section 2. ch. 3), his praise rises still higher. Amongst other things, he says: 'Personne n'a mieux connu que lui la cause de nos erreurs; car il a vu que les idées, qui sont l'ouvrage de l'esprit, avaient été mal faites, et que, par conséquent, pour avancer dans la recherche de la vérité, il fallait les refaire.' * * * * 'Bacon proposait une méthode trop

parfaite, pour être l'auteur d'une révolution, et celle de Descartes devait réussir, parce qu'elle laissait subsister une partie des erreurs.' In the Histoire Moderne (which, however, appeared after the publication of the Encyclopédie), besides passing a high eulogium on Bacon, he gives a brief summary of a portion of the First Book of the Novum Organum. See livre xx. ch. 12. It may be worth noticing that Condillac's objections to Bacon's threefold division of the sciences are peculiarly acute and effective.

In 1751 appeared the Encyclopédie. This work not only contained a flattering article on 'Baconisme,' but, in the Discours Préliminaire by D'Alembert, he is styled 'le plus grand, le plus universel, et le plus éloquent des Philosophes.' The exaggerated tone here adopted (as, for instance, 'Bacon né dans le sein de la nuit la plus profonde, sentit que la Philosophie n'étoit pas encore'), as well as the fact that the Encyclopedists claimed Bacon as one of themselves, not unnaturally gave rise to a violent reaction against him, such as we witness in the work of De Maistre.

It is unnecessary to pursue any further the subject of Bacon's reputation and influence in France, and we now turn to Italy.

That Bacon's works were well known and esteemed in Italy, even during his lifetime, is plain from the following passage in the Life of Bacon prefixed by Rawley to his Resuscitatio, published in 1657:

'His fame is greater and sounds louder in foreign parts abroad, than at home in his own nation; thereby verifying that divine sentence, *A prophet is not without honour, save in his own country, and in his own house.* Concerning which I will give you a taste only, out of a letter written from Italy (the storehouse of refined wits) to the late Earl of Devonshire, then the Lord Candish: *I will expect the new essays of my Lord Chancellor Bacon, as also his History, with a great deal of desire, and whatsoever else he shall compose: but in particular of his History I promise myself a thing perfect and singular, especially in Henry the Seventh, where he may exercise the talent of his divine understanding. This lord is more and more known, and his books here more and more delighted in; and those men that have more than ordinary knowledge in human affairs, esteem him one of the most capable spirits of this age; and he is truly such.* Now his fame doth not decrease with days since, but rather increase. Divers of his works have been anciently and yet lately translated into other tongues, both learned and modern, by foreign pens.'

Further evidence of the same fact is furnished by Bacon's cor-

respondence with two distinguished Italian ecclesiastics, Father Baranzan and Father Fulgentio. Bacon's very interesting letter to the former, who was a young professor of mathematics and philosophy at Annecy in Savoy, was preserved by J. P. Niceron in his Mémoires, and is reproduced by Mr. Spedding in his seventh volume of Bacon's Life and Letters, pp. 374–378. Baranzan's letter, which called forth this response, is unfortunately not extant. With Father Fulgentio, who, according to Archbishop Tenison[17], was 'a Divine (if I mistake not) of the Republic of Venice, and the same who wrote the Life of his Colleague, the excellent Father Paul,' passed at least one interchange of letters. Here, again, the letter of Fulgentio is unfortunately lost, but Bacon's reply is given in Tenison's Baconiana (pp. 196–200), and in the seventh volume of Spedding's Life and Letters of Bacon, pp. 531–533.

Attention is drawn by Mr. Napier to a curious and interesting letter from Toby Matthew to Bacon, dated Brussels, April 4, 1619[18], in which he connects the name of Bacon with that of Galileo. 'It may please your Lordship, there was with me this day one Mr. Richard White, who hath spent some little time at Florence, and is now gone into England. He tells me, that Galileo had answered your discourse concerning the flux and reflux of the sea, and was sending it unto me; but that Mr. White hindered him, because his answer was grounded upon a false supposition, namely, that there was in the ocean a full sea but once in twenty-four hours. But now I will call upon Galileo again.' As the tract De Fluxu et Refluxu Maris was not published till it was included in Gruter's collection of 1653, it must have been communicated to Galileo in manuscript, thus shewing the interest already taken in Bacon's writings. It is true, I believe, that Galileo makes no mention of Bacon's works, but then, as I shall presently have occasion to remark, and as we have already seen in the case of Locke, the habit of referring to contemporary or recent writers was at this time comparatively rare.

Vico, the celebrated Italian Publicist (b. 1668, d. 1744), frequently alludes to Bacon. In the Scienza Nuova (in its second form), lib. ii. (Works, Milan Ed. of 1836, vol. v. p. 253), he bears this testimony: 'Onde a gran ragione il Verulamio, gran filosofo egualmente e politico, propone, commenda ed illustra l'Induzione nel suo Organo;

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[17] Account of all the Lord Bacon's Works, prefixed to the Baconiana, p. 101.

[18] See Spedding's Life and Letters of Bacon, vol. vii. pp. 35–37.

et è seguito tuttavia dagli Inghilesi con gran frutto della Sperimentale Filosofia.' I am indebted for this reference to M. Rémusat, who cites the French translation published in 1844, p. 165.

Mr. Napier, with the most commendable industry, collects the German testimonies to Bacon from the Frankfort Edition of Campanella's Realis Philosophia Epilogistica by Tobias Adams in 1623 down to the Compendium Historiae Philosophicae of Buddaeus, published in 1731. In the Preface to the first-mentioned book, the aim and method of Campanella are compared with those of Bacon, 'sagacissimus Philosophus' (who, it must be remembered, was still alive, and working at the Instauratio Magna), 'quamvis non dubitem quin longe plura et majora per inductiones diligentiores, quibus ille insistit, investigari, multaque emendari et elucidari rectius possint.' The next authority to which Mr. Napier refers is Commenius's Synopsis Physicae ad lumen divinum reformatae, published in 1643. This author, who speaks of Bacon ('magnus Verulamius') in his Preface with the greatest respect, also couples him with Campanella: 'hos enim Hercules, qui debellandis monstris expurgandisque Augiae stabulis, feliciter admoverunt manus commonstrasse; et illis, quos Aristotelicae vane turgidae Philosophiae dementatos tenet authoritas, opposuisse, sufficiat.'

In 1652, Isaac Gruter, writing to Rawley in reference to a projected edition of Bacon's works, speaks of them as 'diu faventissimis Eruditi mundi praeconiis et applausu contestatissimo excepta.' Baconiana, p. 224.

The famous jurist Puffendorf is quoted by Sir Thomas Pope Blount (Censura Celebriorum Authorum, p. 635) to the following effect: 'Sapientissimus quondam Angliae Cancellarius, qui praecipue nostro saeculo velut classicum cecinisse et signum sustulisse videtur, ut in rebus philosophicis aliquid ulterius et exquisitius investigaretur, quam quo hactenus Scholarum parietes resonuerant. Sic ut si quae est pulchrius nostro tempore efflorescentis Philosophiae gratia, isti viro non minima ex parte debeatur.' Specim. Controvers. cap. i. sect. 5.

But more important than the testimony of any of these writers is that of Leibnitz. In the Confessio Naturae contra Atheistas (1668), he begins: 'Divini ingenii vir Franciscus Baconus de Verulamio recte dixit,' &c. In his account of his own studies, under the name of Wilhelmus Pacidius (Opera Philosophica, Ed. Erdmann, pp. 91, 92), he says, 'Interea feliciter accidit ut consilia magni viri Francisci

Baconi, Angliae Cancellarii, de augmentis scientiarum, et cogitata excitatissima Cardani et Campanellae et specimina melioris philosophiae Kepleri et Galilei et Cartesii ad manus pervenirent.' He, then, felt himself, as it were, carried into another world (velut in alium orbem delatus). Again, in the De Stilo Philosophico Nizolii (p. 61) he describes the 'incomparable Verulam' and other famous men as having recalled philosophy 'ex aeris divagationibus aut etiam spatio imaginario ad terram hanc nostram et usum vitae.' And in one of his Reflections, printed under the title of 'Leibnitiana' (Opera Philologica, Ed. Dutens, vol. vi. p. 303), where he is comparing the 'ingenium acutum' with the 'ingenium magnum,' he speaks in terms which to many will appear exaggerated: 'Etiam in scriptoribus has differentias agnosco. Quid Cartesio in physicis, Hobbio in moralibus acutius? At si ille Bacono, hic Campanellae comparetur, apparet illos humi repere; hos magnitudine cogitationum, consiliorum, immo destinationum assurgere in nubes, ac pene humanae potentiae imparia moliri. Illi ergo tradendis principiis, hi conclusionibus ad usum insignibus eliciendis meliores.' It is curious so frequently to find the name of Bacon coupled by German writers with that of Campanella.

Not the less important for being discriminating is the very interesting and judicious testimony of the celebrated physicist, Huygens, in his annotations on Baillet's Life of Descartes (which work appeared in 1691). This passage is preserved by Cousin in his Fragments Philosophiques, tome ii. p. 160, and proceeds as follows: 'Les modernes, comme Telesius, Campanella, Gilbert, retenoient de mesme que les Aristotéliciens plusieurs qualités occultes, et n'avoient pas assez d'invention et de mathématiques pour faire un système entier; Gassendi non plus, quoyqu'il ait reconnu et découvert les inepties des Aristotéliciens. Vérulamius a vu de mesme l'insuffisance de cette philosophie péripatéticienne, et de plus a enseigné de très bonnes méthodes pour en bâtir une meilleure à faire des expériences et à s'en bien servir. Il en a donné des exemples assez rares, pour ce qui regarde la chaleur dans les corps, qu'il conclut n'estre qu'un mouvement des particules qui les composent. Mais au reste il n'entendoit point les mathématiques et manquoit de pénétration pour les choses de physique, n'ayant pas pu concevoir seulement la possibilité du mouvement de la terre, dont il se moque comme d'une chose absurde.' Then follows an estimate of Galileo and Descartes.

Morhof, in his Polyhistor (tom. ii. lib. 2. cap. 1), has a special chapter entitled: 'Quomodo Historia Naturalis sit instituenda, e

mente Francisci Baconis Verulamii, et ejus sequentium vestigia.' Here and elsewhere he is profuse in his praise of Bacon.

Boerhaave, who, as Mr. Napier says, was himself an eminent improver of science in several of its branches, and who was placed in a situation, which, in a particular manner, enabled him to collect the general sentiment of Europe upon any point connected with the history of philosophy, in his Discourse de comparando certo in Physicis, delivered before the University of Leyden in 1715, pronounced an eulogium on Bacon which it would be difficult to exceed: 'Atque hujus quidem Physices fortunas laudare licet ex quo magnum Verulamium summo suo bono accepit! Virum certe ad omnia, quae scientia humana comprehendi possunt, indaganda facile principem, et de quo dubites utrum consilio, an exemplo, major fuerit in instauranda deformata Physica. Absque invidia dixero, quidquid incrementi cepit naturalis historia ab ineunte decimo sexto seculo in hanc usque horam, omne id acceptum debemus monitis et preceptis illius viri; cujus indelibilem memoriam grata colet orbis perpetuitas.'

Similar is the testimony of Buddaeus (Compendium Historiae Philosophicae, Ed. of 1731, pp. 409–412): 'Saeculo decimo septimo ineunte, nova lux philosophiae, praesertim in scientia naturali, orta est. Exemplum omnibus praeivit Franciscus Baco de Verulamio, qui, ut, missis abstractis illis et otiosis speculationibus, ad particularia descenderent experimentaque instituendo naturam rerum accuratius contemplarentur, omnibus auctor fuit. Hujus ductum cum multi sequerentur, dici non potest, quanta ad accuratiorem philosophiam facta sit accessio.'

Morhof (Polyhistor, tom. i. lib. 2. cap. 7) speaks of a work, published in Hungary in 1663, by one John Beyer, entitled 'Filum Labyrinthi vel Cynosura, sive Lux mentium universalis,' &c., in which the author attempted to expound the Baconian philosophy. 'Verum obscurat potius Verulamii sensus omnemque philosophiam, quam ut lumen aliquod accendat.' This fact is interesting as showing that the fame of Bacon's philosophical reform had reached even remote countries like Hungary.

On the possible, or, perhaps, probable influence of Bacon's writings on the institution of scientific societies abroad, I shall have occasion to speak in a note on the next division of my subject.

Returning to England, I shall now attempt to shew the influence

of Bacon's writings on the group of men who founded the Royal Society or were amongst its earliest members, and the estimation in which he was held by them. This Society, as is well known, originated in certain informal meetings during the Civil Wars (according to Dr. Wallis in 1645), though it did not receive its Charter of Incorporation till 1662. Now Bishop Sprat, its earliest historian, in a work written in 1667, speaks of Bacon, as having 'had the true imagination of the whole extent of this enterprise, as it is now set on foot.' And then he proceeds: 'In whose books there are everywhere scattered the best arguments, that can be produced for the defence of Experimental Philosophy; and the best directions that are needful to promote it. All which he has already adorned with so much art; that if my desires could have prevailed with some excellent friends of mine, who engaged me to this work: there should have been no other Preface to the History of the Royal Society, but some of his writings.' The passage is too long to quote at length, but will be found in Dr. Sprat's History of the Royal Society, pp. 35, 36, and in Tenison's Baconiana, pp. 264–266. What Sprat, notwithstanding his eulogium of the philosophical works in general, says of the Sylva Sylvarum is unfortunately very true: 'He seems rather to take all that comes, than to choose; and to heap rather than to register.' 'But,' he adds, though 'he had not the strength of a thousand men, I do allow him to have had as much as twenty.'

In another place (p. 144), after complimenting Lord Clarendon and the other Law Officers of the Crown on their share in drawing up the Charter of the Royal Society, Sprat goes on to say: 'But it is enough to declare that my Lord Bacon was a Lawyer, and that these eminent officers of the Law have completed this foundation of the Royal Society: which was a work well becoming the largeness of his Wit to devise, and the greatness of their Prudence to establish.' The allusion here, I presume, is to the New Atlantis.

In Cowley's Ode to the Royal Society, Bacon's name is equally prominent:

'Some few exalted Spirits this latter Age has shown,
That labour'd to assert the Liberty
(From Guardians, who were now Usurpers grown)
Of this Old Minor still, captiv'd Philosophy;
    But 'twas Rebellion call'd to fight
    For such a long oppressed Right.
Bacon at last, a mighty man, arose
    Whom a wise King and Nature chose
    Lord Chancellour of both their Laws,
And boldly undertook the injur'd Pupil's cause.'

He then describes how he chased away Authority,

> 'Nor suffer'd Living men to be misled
> By the vain shadows of the Dead:'

how he broke the 'Scar-crow Deitie' of the orchard, how he brought the mind from words to things, &c.

> 'From these and all long Errors of the way,
> In which our wandring Praedecessors went,
> And like th' old Hebrews many years did stray
> In Desarts but of small extent,
> Bacon, like Moses, led us forth at last,
> The barren Wilderness he past,
> Did on the very Border stand
> Of the blest promis'd Land,
> And from the Mountain's Top of his Exalted Wit,
> Saw it himself, and shew'd us it.'

It should be noticed that Sprat's book received the sanction of the Royal Society, and that copies of it were sent by them to foreign princes and other eminent persons on the continent. Hence Liebig's sneer at Sprat (Allgemeine Zeitung, March 7, 1864), unless he is prepared to extend it generally to the members of the Royal Society at that time, is entirely out of place.

But there is much more evidence to the same effect. The celebrated mathematician, Dr. Wallis, in the very interesting Account of some Passages of his own Life, published in Appendix, Num. xi, to Hearne's Preface to Peter Langtoft's Chronicle[19], says: 'About the year 1645, while I lived in London, * * * * * I had the opportunity of being acquainted with divers worthy Persons, inquisitive into Natural Philosophy, and other parts of Humane Learning; and particularly of what hath been called the New Philosophy or Experimental Philosophy.' He then proceeds to give the names of his associates and their places of meeting. 'Our business was to Discourse and consider of Philosophical Enquiries, and such as related thereunto.' * * * * * 'Some of which were then but New discoveries, and others not so generally known and imbraced, as now they are, with other things appertaining to what hath been called The New Philosophy; which from the times of Galileo at Florence, and Sir Francis Bacon (Lord Verulam) in England, hath been much cultivated in Italy, France, Germany, and other parts abroad, as well as with us in England.'

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[19] For this reference I am indebted to Mr. Napier.

In the Dedication to the Royal Society of his Scepsis Scientifica (1665), Glanvill says: 'For you really are what former ages could contrive but in wish and Romances; and Solomon's House in the New Atlantis was a Prophetic Scheme of the Royal Society.' Complimentary allusions to Bacon, whom he evidently regards as the great light of modern philosophy, are of constant occurrence in Glanville's works. Mr. Napier cites one more, taken from the Plus Ultra or the Progress and Advancement of Knowledge since the days of Aristotle (1668), having special reference to the Royal Society. After several remarks on the philosophy and aims of Bacon, he proceeds:

'This was a mighty design, groundedly laid, wisely exprest, and happily recommended by the Glorious Author, who began nobly, and directed with an incomparable conduct of Wit and Judgment: But to the carrying it on, it was necessary there should be many Heads and many Hands, and those formed into an Assembly, that might intercommunicate their Tryals and Observations, that might joyntly work, and joyntly consider; that so the improvable and luciferous Phaenomena, that lie scatter'd up and down in the vast Champaign of Nature, might be aggregated and brought into a common store. This the Great Man desired, and form'd a Society of Experimenters in a Romantick Model, but could do no more; His time was not ripe for such performances.'

'These things therefore were consider'd also by the later Virtuosi, who several of them combined together, and set themselves on work upon this grand Design[20].'

Oldenburg, the first Secretary of the Society, in Number 22, p. 391 (1666–7), giving an extract from a letter, continues: 'The ingenious Author of this Letter, as he expresses an extraordinary desire to see the Store-House of Natural Philosophy more richly fraughted (a Work begun by the single care and conduct of the excellent Lord Verulam, and prosecuted by the Joynt-undertakings of the Royal Society) so,' &c. He frequently alludes to Bacon, as having given the chief impulse to the study of Experimental Philosophy, as, for instance, in the Prefaces to the Transactions for 1670, 1672, 1677. Thus, in the Preface for 1670, he says that 'his greatest Reputation rebounded first from the most intelligent Forrainers in many parts of Christendome;' in that for 1672, 'when our renowned Lord Bacon had demonstrated the methods for a perfect Restauration of

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[20] Plus Ultra, pp. 87, 88.

all parts of Real knowledge * * * * * the success became on a sudden stupendous, and Effective philosophy began to sparkle, and even to flow into beams of bright-shining Light, all over the World;' and, lastly, in that for 1677, 'many of the chief Universities in Christendom have already formed themselves into Philosophical Societies, and have so largely contributed their aydes to advance the Lord Bacon's Design for the Instauration of Arts and Sciences, that it is now become above my abilities,' &c.[21]

Boyle, who was himself called a Second Bacon, and who lent his rooms for the meetings of the Royal Society during the latter part of its Oxford career, is constant in his allusions to 'our illustrious Verulam,' 'that profound naturalist the Lord Verulam,' 'so judicious a friend to philosophy and mankind, as Sir Francis Bacon,' 'our famous experimenter, the Lord Verulam himself,' &c., &c.[22] See his works, passim. Indeed Boyle seems to have been regarded, in a special sense, as a disciple of Bacon. In a letter to him, quoted by Mr. Napier, from Dr. Beal, who was himself elected to the Royal Society in 1662, the writer says: 'You have particularized, explicated, and exemplified those fair encouragements and affectionate directions, which Lord Bacon in a wide generality proposed.' Dr. Beal's letters[23], which are somewhat lengthy, are full of allusions to Bacon. Thus, he speaks of Boyle as 'relieving Lord Bacon's Sylva, and his Novum Organum, which oft-times want your aid,' and, in another letter, there

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[21] It may here be noticed that Mr. Napier quotes Büchner, whose work I have not been able to see, as referring the foundation of learned societies throughout Europe to the influence of Bacon: 'Sed, quae superest dicenda, supremam, et, ut nobis videtur, proximam condendae Academiae enarrabimus occasionem. Scilicet postquam, ineunte circiter priori saeculo, non inter Britannos solum, sed universi quoque orbis incolas, immortalitati commendatissimus, Franciscus Baco de Verulamio, variis iisque ad sapientiae normam elucubratissimis scriptis, utilissima emendandae atque instaurandae historiae naturalis dedisset consilia, et absolutissimis rationibus firmasset: non Angli modo haud incassum se moneri atque excitari passi sunt, sed exterae quoque gentes, imprimis Galli Italique, sanioris consilii patientes, tanta contentione cum qualibuscunque scientiis generatim, tum praecipue rerum naturalium studio animum intenderunt, adeo, ut ex illo tempore visi sunt homines nihil, vel remotissimis naturae visceribus abstrusum, quod non captis ex Baconis mente experimentis curiosius rimarentur, relicturi. Atque hic ardor, haec studia magnam quoque partem condiderunt Academiarum Societatumque hactenus memoratarum.' Academiae Naturae Curiosorum Historia, cap. 1. § 7.

[22] And yet Sir David Brewster, in his Life of Newton (ch. 27. vol. ii. p. 403 of 1st Ed.) says that 'the amiable and indefatigable Boyle treated Bacon with the same disrespectful silence' that Newton did. The silence of Newton I shall discuss presently.

[23] These are published amongst the Letters from Several Persons to Mr. Boyle, in the last volume of Boyle's Collected Works.

is a passage bearing on the connection between Bacon's designs and the establishment of the Royal Society: 'And let me say to you, that if you give these things in charge amongst your acquaintance, that each man in his way may add to the search of others, then you do fully prosecute the Verulamian design; then our labour is joined and collegiate, and not always running in the narrowness of single endeavours.' Maclaurin, again, in his Account of Newton's Philosophical Discoveries (p. 61) says: 'It has been observed that Mr. Boyle was born the same year that Lord Bacon died, as if he had been destin'd to carry on his plan.'

I come next to Dr. Robert Hooke (b. 1635, d. 1703), who succeeded Oldenburg as Secretary of the Royal Society, and was amongst the most distinguished of its early members. Amongst his Posthumous Works is published one entitled The Present State of Natural Philosophy and the Method of Improving it, which is described by Dr. Whewell as an 'attempt to adapt the Novum Organum to the age which succeeded its publication.' The whole of this treatise is in the lines of the Novum Organum, and much of it is a mere translation of its language. And yet Hooke seldom mentions Bacon, another proof out of many how little the writers of that time think it necessary to cite by name the authors from whom they borrow or to whom they are under obligations. In one place, however (Posthumous Works, p. 6), he announces his design as follows: 'Some other course therefore must be taken to promote the Search of Knowledge. Some other kind of Art for Enquiry than what hath hitherto been made use of, must be discovered; the Intellect is not to be suffered to act without its Helps, but is continually to be assisted by some Method or Engine, which shall be as a Guide to regulate its Actions, so as that it shall not be able to act amiss: Of this Engine, no Man except the incomparable Verulam hath had any thoughts, and he indeed hath promoted it to a very good pitch; but there is yet somewhat more to be added, which he seemed to want time to compleat.' Hooke's work, like its prototype, was unfinished.

Testimonies of this kind might easily be multiplied to almost any extent. Such are those of John Evelyn, an early member of the Royal Society, and celebrated as the author of Sylva, Numismata [24], the well-known Diary, &c.; of Dr. Joshua Childrey, who, in a letter to

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[24] There are constant allusions to Bacon in both these works, especially in the former; see particularly Numismata, ch. 9. p. 340; Sylva, Address to the Reader (much enlarged in the 3rd Edition).

Oldenburg, preserved by Antony Wood[25], says 'he first fell in love with the lord Bacon's philosophy in the year 1646,' and who, in 1661, published a work entitled 'Britannia Baconica, or the Natural Rarities of England, Scotland, and Wales, historically related, according to the precepts of the Lord Bacon;' together with many other writers whom it would be tedious to enumerate.

The authorities cited are, however, amply sufficient to prove the two points which I was anxious to establish: 1st, that the foundation of the Royal Society in England, and possibly also that of some similar societies on the Continent, was due to the impulse given by Bacon to the study of experimental science and the plans which he devised for its prosecution; 2nd, that some of the more eminent men who were amongst the earliest members of that society, Wallis, Boyle, Hooke, &c., were deeply imbued with the spirit of Bacon's teaching, and ready fully to recognise their obligations to him. If these facts be established, as I think they are, there can be no question as to the reality of Bacon's influence on the progress of science in the generation immediately succeeding his own, whatever we may regard the nature of that influence as having been[26].

Nor was the 'New Philosophy' without its influence on the Universities, much as those bodies were occupied at this time with other questions, and deeply rooted as were their prejudices in favour of the old learning. Even if we pass over the Letter of the University of Oxford[27], written on receipt of Bacon's De Augmentis in 1623, in which he is compared to a literary Hercules, who has further advanced the pillars of learning, deemed by others immovable, as savouring, perhaps, too much of official flattery; and even if we reject, as testimony to himself, and, therefore, perhaps, partial, what he says in his letter to the King[28] about the reception of the Advancement of

[25] Wood's Athenae Oxonienses, vol. iii. p. 904 (Ed. Bliss, 1817). According to Wood, the Britannica Baconica, mentioned in the text, suggested to Dr. Plot his Natural History of Oxfordshire.

[26] For further evidence of Bacon's influence on the group of men who founded the Royal Society, or were amongst its earliest members, see the section on the Opponents of Bacon, under Dr. Henry Stubbe.

[27] Published in Baconiana, pp. 204-206. The letter is written, throughout, in the most flattering strain, but, as Mr. Napier remarks, 'this piece of homage was offered at a time when all motives to interested adulation had been done away by Bacon's lamentable fall.' The following is a specimen of the language of this letter: 'Creverunt quidem [musae], et sub calamo tuo, qui tanquam strenuus literarum Alcides, Columnas tuas, Mundo immobiles, propria manu in Orbe Scientiarum, *plus ultra* statuisti. Euge exercitatissimum Athletam,' &c.

[28] 'One thing, I confess, I am ambitious of, with hope, which is that after these

Learning 'in the universities here and the English colleges abroad,' we have still sufficient evidence to shew that his works were producing a real and perceptible influence.

The ready welcome accorded to the London *savans* in Oxford in 1648 and 1649 (see Wallis's account), the fact that they were joined by several Oxford men, and the uninterrupted meetings of the incipient Royal Society in Oxford till the dispersion of several of its members in 1658, would alone furnish satisfactory evidence of the spread of the 'New Philosophy' in one, at least, of the Universities[29]. But Bp. Sprat expressly tells us (p. 53) that, besides being 'frequented by some Gentlemen of Philosophical Minds, whom the misfortunes of the Kingdom and the security and ease of a retirement amongst Gown-men had drawn thither,' 'the University had, at that time, many members of its own, who had begun a free way of reasoning,' an expression which undoubtedly denotes the Baconian, as opposed to the Aristotelian or traditional method. In describing their meetings, he proceeds: 'By this means there was a race of young men provided, against the next age, whose minds, receiving from them their first impressions of sober and generous knowledge, were invincibly armed against all the enchantments of Enthusiasm. But what is more, I may venture to affirm, that it was in good measure by the influence, which these Gentlemen had over the rest, that the University itself, or, at least, any part of its Discipline and Order, was saved from ruin.'

At a period a little later than the publication of Sprat's book, Dr. Beal, writing to Boyle, Nov. 27, 1671, has a passage which will be read with some interest by many Oxford men, and which, as I have not seen it noticed before, I transcribe at length:

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beginnings, and the wheel once set on going, men shall suck more truth out of Christian pens, than hitherto they have done out of heathen. I say with hope, because I hear my former book of the Advancement of Learning is well tasted in the Universities here and the English colleges abroad: and this [the Novum Organum] is the same argument sunk deeper.' Letter to the King, in 1620, printed in Spedding's Life and Letters, vol. vii. pp. 119, 120.

[29] And yet the Juniors do not seem, at any rate in some of the Colleges, to have profited much from this intellectual activity of their seniors. See Locke's account of the arid and unstimulating character of his studies during the earlier years of his academical life, as given in his confidences to Lady Masham and Le Clerc (Fox Bourne's Life of Locke, vol. i. pp. 47, 48). In referring to Mr. Fox Bourne's work, I must not be supposed to endorse altogether his account of the Oxford curriculum at this time, much of which appears to me to be an ideal construction. Locke, in later years, joined the scientific circle of which Boyle was the centre.

'At my request a young Oxonian prepared me a list of fit, capable, and hopeful persons, addicted to the design of the Royal Society, and willing to entertain correspondencies, and to assist in them. They seemed to me by their qualifications, and number, very considerable; some in every college, and in every hall. Only in one college, there was but one named; but it is excused, that his list was much too short, and that he wanted time to complete it, and for some reasons he would not be seen to advise with others for fuller information. There are excellent professors, some lecturers, and very many students of useful arts amongst them. And in time they may have their meetings in some of their publick schools, after fit lectures; and the wings of the Stubbians are already broken, and their reputation withers, as Dr. Bathurst told me.' Boyle's Works, Ed. of 1744, vol. v. p. 498, b.

Mr. Napier, to whom I am indebted for the two next references, thinks that the 'new philosophy' had made still greater progress at Cambridge. This conclusion is based mainly on a passage in Antony Wood (Bliss's ed. of the Athenae Oxonienses, 1817, vol. iii. p. 1244), who, in his Life of Glanvill, 'wonders, considering that that house [Exeter College] was then one of the chief nurseries for youth in the university, why he should afterwards lament that his friends did not first send him to Cambridge, because, as he used to say, that new philosophy and the art of philosophising were there more than here in Oxon, and that his first studies in this university did not qualify him for the world of action and business.' This evidence, which I have thought better to give in full, may not be of much value as settling the claims of the rival Universities, but, at all events, it is sufficient to shew that Cambridge had already a reputation for the 'new philosophy.' Of this, perhaps, we receive additional testimony in Baker's Reflections upon Learning, first published in 1699. This author was a Fellow of St. John's College, Cambridge, and is now well known for his history of that College, recently published and edited by Mr. Mayor. In the former work (Chapter on Logic), after making some interesting remarks on the Method of Bacon, he proceeds: 'After the way of free thinking' (notice, again, this expression) 'had been lai'd open by my Lord Bacon, it was soon after greedily follow'd, for the Understanding affects Freedom as well as the Will, and men will pursue liberty, tho it ends in confusion.' p. 59. This reflection, however, may have simply a general reference, and may not have been specially suggested by the experience of the writer's own University.

It would be superfluous to extend this enquiry beyond the point at which we have now arrived, as, at the end of the seventeenth century, we are already in the full tide of experimental research, when the fame and influence of Bacon were, as I believe, universally acknowledged [30]. But, before I proceed to consider the nature of this influence, it is necessary that I should entertain a question which has been the occasion of considerable dispute, namely, the cause of the complete, and, as it has seemed to some, singular silence as to Bacon which is maintained by his illustrious successor, Newton. Some refer it to contemptuous indifference. Thus, Sir David Brewster, whose judgment Rémusat accepts, roundly asserts that 'Newton would have enriched science with the same splendid discoveries, if the name and the writings of Bacon had never been heard of,' and says oddly enough, as I have already pointed out, that 'Boyle treated him with the same disrespectful silence [31].' On the other hand, Horace Walpole [32] calls Bacon 'the Prophet of Arts, which Newton was sent afterwards to reveal,' and Reid [33] speaks of Newton, as 'having, in the third book of his Principia and in his Optics, had the rules of the Novum Organum constantly in his eye.' Between these conflicting views I shall attempt to decide, considering, first, the external evidence of Bacon's influence on Newton, secondly, the internal evidence, so far as it can be derived from Newton's own writings, and, lastly, the interpretation to be put upon his silence with respect to Bacon's name and works.

Pemberton, in his View of Sir Isaac Newton's Philosophy (1728), informs us distinctly that Newton 'approved of the following treatise, a great part of which we read together' (Preface). Now, in the Introduction to this work, the author almost at once begins to speak of the irrational method formerly pursued in scientific enquiries, by 'framing conjectures,' 'undertaking intire systems,' 'fathoming at once the greatest depths of nature,' &c. 'Whereas the only method, that can afford us any prospect of success in this difficult work, is to make our enquiries with the utmost caution, and by very slow degrees.' 'This neglect,' he proceeds, 'of the proper means to enlarge our knowledge, joined with the presumption to attempt what

[30] See, for instance, Tatler, No. 267; Spectator, No. 554. But the merits and influence of Bacon were now so much taken for granted, that, naturally enough, less was probably said about them than in the previous generation.

[31] Brewster's Life of Newton, vol. ii. p. 403.

[32] Royal and Noble Authors, vol. i. p. 162.

[33] Reid's Account of Aristotle's Logic, ch. 6. sect. 2 (Hamilton's Ed. of Reid's Works, p. 712 b).

was quite out of the power of our limited faculties, the Lord Bacon judiciously observes to be the great obstruction to the progress of science. Indeed that excellent person was the first who expressly writ against this way of philosophising; and he has laid open at large the absurdity of it in his admirable treatise, intitled *Novum Organon Scientiarum;* and has there likewise described the true method, which ought to be followed.' He then goes on to give a copious account of some portions of the First Book of the Novum Organum, especially of the 'Duo viae' (Aph. 19) and the 'Idola,' and then continues: 'But what surprizing advancements in the knowledge of nature may be made by pursuing the true course in philosophical enquiries, when those searches are conducted by a genius equal to so divine a work, will be best understood by considering Sir Isaac Newton's discoveries.' In attempting to give an account of the 'principles whereon Sir Isaac Newton proceeds,' the author evidently has Bacon's method constantly in view, and, in expounding the third of the 'Regulae Philosophandi,' he again mentions him by name: 'The only caution here required is * * * * * as the Lord Bacon very judiciously directs.' Now, supposing Newton to have seen this Introduction, as seems very probable, the controversy may be regarded, I think, as determined, and we may, at least, conclude that Newton would have been ready to acknowledge his obligations to the precepts and warnings, contained in the First Book of the Novum Organum.

Maclaurin, again, in his Account of Sir Isaac Newton's Philosophical Discoveries (published, after his death, in 1748), evidently regards the connection between Bacon and Newton as a very close one. The whole of his remarks on Bacon are well worth attention (see pp. 56-62). I can only give one or two brief extracts. 'Sir Francis Bacon, Lord Verulam, who was cotemporary with Galileo and Kepler, is justly held amongst the restorers of true learning, but more especially the founder of experimental philosophy.' * * * * * 'He proposed his plan in his *Instauratio Magna*, with so much strength of argument, and so just a zeal, as renders that admirable work the delight of all who have a taste for solid learning.' * * * * * In his Novum Organum 'his chief design is to shew how to make a good induction, as Aristotle's was to teach how to make a good syllogism. Had the philosophers, since Lord Verulam's time, adhered more closely to his plan, their success had been greater; and Sir Isaac Newton's philosophy had not found the learned so full of prejudices against it, in favour of some systems lately invented and

mightily extolled by speculative men; that while all admired the sublime geometry which shone throughout his work, few for some time appeared to be disposed to hearken to his philosophy, or in a condition to judge of it impartially. However, Lord Bacon's exhortations and example had a good effect; and experimental philosophy has been much more cultivated since his time than in any preceding period. Geometry and philosophy advanced together at a great pace, and gave mutual aid to each other.'

Though Newton's works contain no direct reference to Bacon, there are passages which make it very difficult to suppose that he was not acquainted with, at least, the first book of the Novum Organum either through his own reading or through the common tradition of its teaching. Of the Regulae Philosophandi (contained in Horsley's Edition of Newton's Works, vol. iii. pp. 2–4), the third has already been referred to in my extract from Pemberton. But, for our present purpose, the fourth is still more to the point. It runs as follows:

'In Philosophia experimentali, Propositiones ex phaenomenis per inductionem collectae, non obstantibus contrariis hypothesibus, pro veris aut accurate, aut quam proxime, haberi debent, donec alia occurrerint Phaenomena, per quae aut accuratiores reddantur, aut exceptionibus obnoxiae.'

'Hoc fieri debet, ne argumentum inductionis tollatur per hypotheses.'

This rule, both in substance and expression, is thoroughly Baconian, and, I venture to suggest, could hardly have been stated as it is by any one not acquainted with the Baconian philosophy.

At the end of the third book of the Optics (Horsley's Ed., vol. iv. pp. 263, 264), there is a longer and fuller passage, much to the same effect:

'As in Mathematicks, so in Natural Philosophy, the investigation of difficult things by the method of analysis [34], ought ever to precede the method of composition. This analysis consists in making experiments and observations, and in drawing general conclusions from them by induction, and admitting of no objections against the conclusions, but such as are taken from experiments, or other certain

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[34] On Newton's use of the words Analysis and Synthesis, see Dugald Stewart's Elements of the Philosophy of the Human Mind, pt. ii. ch. 4. sect. 3. subsect. 2 (Hamilton's Ed., vol. iii. p. 272, &c.).

truths. For hypotheses are not to be regarded in Experimental Philosophy. And although the arguing from experiments and observations by induction be no demonstration of general conclusions; yet it is the best way of arguing which the nature of things admits of, and may be looked upon as so much the stronger, by how much the induction is more general. And if no exception occur from phaenomena, the conclusion may be pronounced generally. But if at any time afterwards any exception shall occur from experiments; it may then begin to be pronounced, with such exceptions as occur. By this way of analysis we may proceed from compounds to ingredients; and from motions to the forces producing them; and, in general, from effects to their causes; and from particular causes to more general ones, till the argument end in the most general. This is the method of Analysis. And the Synthesis consists in assuming the causes discovered, and established as principles, and by them explaining the phaenomena proceeding from them, and proving the explanations.'

This passage, while undoubtedly showing, as it seems to me, an acquaintance with the Baconian method, is remarkable as denying to induction the force of demonstration (a limitation which we may, perhaps, account for from Newton's mathematical habit of mind and the preponderance of his mathematical pursuits), as well as for the fact that it does not appear to recognise any other form of induction than that 'per enumerationem simplicem.' Both these circumstances incline me to believe that Newton had not studied, or did not remember, or did not accept the teaching of the early part of the Second Book of the Novum Organum, though the precepts and warnings of the First Book, in their most general form, had produced a deep impression upon him and had, in great measure, suggested to him the aims and methods of his own investigations [35].

How then are we to account for his silence, as respects the name

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[35] Dr. Hippus, the author of the Account of the Novum Organum in the Library of Useful Knowledge (pt. i. p. 10), adopting a remark of Dugald Stewart (Elements, Ed. Hamilton, vol. ii. p. 236), adduces Newton's application of the word 'axiom' to the Laws of Motion and the higher generalisations of Optics, as a proof of the influence exercised on him by Bacon's logical phraseology. This argument may have some weight, but, as I shall point out in a note on Bk. i. Aph. 7, Newton does not use the word 'axiom' with so much latitude as does Bacon, and, moreover, in the manuals of logic which he probably read as a young man, so far from finding the word restricted, as at present, to self-evident propositions in mathematics, he would find it used as the equivalent of Proposition in general.

and writings of Bacon? In the first place, I think that the reputation of Bacon, as a reformer of scientific method, had now become so established a fact, and the leading principles of his philosophy so well known, that explicit reference to him was superfluous. Those who were constantly engaged in the pursuit of experimental philosophy now no more thought of referring to Bacon as an authority for the general principles on which they proceeded, than those engaged in the disputes of the schools thought of referring explicitly to the works of Aristotle or their manuals of logic. And yet, in each case, they would have been perfectly ready to acknowledge the extent of their obligation, if any doubt had been cast upon it.

In the second place, I must recall to the mind of the reader what I have already more than once had occasion to mention, namely, the comparative rarity of references to contemporary or recent writers amongst the authors of the period of which I am treating. Thus, we have seen that Locke, though, as I conceive and as is generally supposed, owing the method and even the leading ideas of his philosophy to Bacon, never mentions him by name or makes any direct allusion to his writings. Galileo, as I have already remarked, was, I believe, equally silent. But, then, Galileo makes no mention of some of the most important discoveries of Kepler, even when it lay in his way to do so[36]. Again, Kepler is never mentioned by Descartes, and 'in treating of the rainbow,' says Professor Playfair[37], 'Descartes has made no mention of Antonio de Dominis.' I cannot believe that, in all these cases, the silence is due to either contempt or vanity or dishonesty, though, then as now, any of these motives may in any particular case have been operative. I am rather inclined to suppose that the authors of that time, writing for a learned class, often did not think it necessary to mention books or discoveries which were familiar to their readers, while we, writing for a more general public, should be liable to be accused of ignorance or plagiarism, if we were to observe a similar silence.

Lastly, Newton's tastes and genius lay rather in the way of mathematical science than of experimental philosophy, properly so called. Bacon's weakness, on the other hand, consisted in his deficiency of mathematical knowledge, and his consequent incapacity of properly estimating or criticising those branches of science which were already

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[36] See, on this subject, some most interesting remarks of Delambre, Histoire de l'Astronomie Moderne, tome i. pp. 651–653 (1st Ed.).

[37] Preliminary Dissertation.

expressed, or already admitted of being expressed, in a mathematical form. Hence, we cannot be surprised if the names of Copernicus, Galileo, and Kepler had for Newton a greater attraction than that of Bacon, though it by no means follows that he regarded him otherwise than with respect and admiration, or that he would not have been ready fully to express his obligations to him for having insisted on raising the superstructure of experimental, and therefore ultimately of all science, on the true foundations of observation, experiment, and induction.

Having now, as I conceive, succeeded in establishing the fact of Bacon's influence on the progress of science, I have next to ask what the nature of that influence was. The title of founder or father of experimental philosophy, ascribed to him by Maclaurin and others, expresses the nature of his influence in a rough, and, perhaps, a somewhat exaggerated as well as a somewhat inadequate form, but one which, I think, is, in the main, true. Instead, however, of criticising this or similar expressions, it is better that I should state precisely the conclusions on this subject at which I have myself arrived.

1st, He called men, as with the voice of a herald[38], to lay themselves alongside of nature, to study her ways, and imitate her processes. To use his own homely simile, he rang the bell which called the other wits together[39]. Other men indeed had said much the same thing in whispers or in learned books written for a circle of select readers; but Bacon cried it from the house-tops, and invited all men to come in freely and partake of the feast. In one word, he popularised the study of nature.

2nd, He insisted, both by example and precept, on the importance of experiment as well as observation. Nature, like a witness, when put to the torture, would reveal her secrets. Experimentation was undoubtedly common in Bacon's time, but it was generally associated with the Alchemists, and so, while it suffered in reputation, it was confined in range. Bacon gave it an extension, a dignity, a popularity which, it is not too much to say, must have materially influenced the labours of the Royal Society, and the crowning efforts of Boyle and Newton.

[38] Thus, he says of himself (De Augm. iv. 1 ad init.): 'Ego enim buccinator tantum,' &c.

[39] 'I have only taken upon me to ring a bell to call other wits together.' Letter to Dr. Playfer, printed in Spedding's Letters and Life, vol. iii. p. 301.

3rd, In both these ways, Bacon recalled men to the study of facts, and though, in the first instance, he had mainly in view the facts of external nature, the influence of his teaching soon extended itself, as he undoubtedly purposed that it should do, to the facts of mind, conduct, and society. The inductive study of Mental, Moral, and Political Philosophy, which has been the distinctive characteristic of the best English thought from the end of the seventeenth century onwards, is, it seems to me, no less really, though I grant it is less obviously, a result of the Baconian teaching than the inductive study of Natural Philosophy.

4th, In order to set men free to study facts, it was necessary to deliver them from the pernicious subjection to authority, to which they had so long been enslaved. Here and there throughout the Middle Ages, a solitary thinker, like Roger Bacon, may have asserted his independence, and, during the century preceding Bacon's time, the murmurs of discontent had been becoming loud and frequent, but it required a clear, shrill voice, like that of the author of the Great Instauration, effectually to awaken men from their slumber. Bacon seems to have been thoroughly impressed with the feeling that there was no hope for human fortunes, unless these bonds could be broken; and hence the tone of intended and conscious exaggeration with which he often sets about this task, as is especially the case in the Temporis Partus Masculus and some parts of the Novum Organum. Nor can I doubt that his utterances on this subject had far more influence in producing the intellectual revolution which followed than the utterances of any one of his predecessors, or, perhaps, than those of all taken together. It would hardly, I think, be an exaggeration to compare Bacon, in the intellectual sphere, with Luther, in the sphere of religion. And, in truth, there was much in common between the two men. Both of them were intensely impressed with the importance and reality of their mission; both of them were grimly in earnest; both of them spurned all obstacles in existing opinion, and even exaggerated the differences between themselves and their opponents; and, lastly, each of them retained, far more than he suspected, the habits of thought, the more deeply-engrained prejudices, and even the more misleading forms of expression of his time. Each of them, in fact, sowed the seed, without knowing altogether clearly what manner of fruit it was likely to bring forth.

5th, Hardly less important than deliverance from the bondage of authority was the emancipation of reason from the bewitching enchantments of imagination. 'Hypotheses non fingo' was a maxim

which Newton inherited directly from the teaching of Bacon. And, though the reaction against hypothesis was carried much too far, and though Bacon's utterances on this subject, to be serviceable at the present time, require much rectification, the warning was one which, in his own time, was sorely needed, and which could hardly be expressed in language too emphatic. Where authority was wanting, as if by way of revenge, men seemed to put no limit to the wildness of their fancies or the extravagance of their suppositions. Now, as against both authority and hypothesis, Bacon invoked the majesty of facts. The office of Reason, he was, in effect, constantly saying, ought not to be limited to an examination of the conclusions, and their dependance on the premisses; what it ought to insist on doing, is to examine the premisses themselves. What is required is a new Logic, a Logic of Induction, which shall do for the premisses what the old Logic, the Logic of Deduction, does for the conclusions. It is not enough that the conclusion follows from the premisses; what we require to know is whether the premisses themselves be true, and, unless we can succeed in satisfying this want, we may simply be multiplying error instead of advancing truth. Had this been the only lesson which Bacon read to his generation, he would, assuredly, have deserved to be reckoned amongst the greatest of its benefactors.

6th, But, to this Logic of Induction I maintain that he himself made no contemptible contributions. That our instances require to be selected and not merely accumulated, was a very true and a very needful lesson which he was never weary of repeating. And, surely, in this maxim consists the whole gist of the Inductive Logic. On what principles we shall select our instances, and by what means we shall satisfy ourselves of their sufficiency, are other and further questions, confessedly most difficult to answer, on which we could hardly expect much detailed or permanently useful information from a pioneer in this method of inquiry. And yet Bacon is very full on at least the first of these questions, and much of what he says has, even still, a value for the student. But we are now concerned, we must recollect, not with the present value of his works, but with their past influence. Now, to the amount of that influence, with respect to the subject before us, what better testimony can we have than the repetition of these rules in the next generation by so eminent a man of science as Dr. Robert Hooke, or the appropriation, emendation, and formulation of them, as the bases of their own methods, almost within our own time, by Sir John Herschel and Mr. Mill? Nor is it an unimportant consideration that such phrases as 'glaring instance,'

'crucial instance,' 'clandestine instance,' 'solitary instance,' and the like, have become household words in our language, and especially in the vocabulary of scientific men.

7th, The manner in which he insisted on the subordination of scientific enquiries to practical aims, the furtherance of man's estate and the increase of his command over the comforts and conveniences of life, is another point in which, I think, Bacon profoundly influenced succeeding generations. That his view was too exclusive, and his language exaggerated, I readily own, but here again, as in criticising the abuse of authority and imagination, I think it difficult to deny that his influence was, on the whole, most beneficial. When we recollect the frivolous character of many of the questions which men of the most brilliant abilities were then in the habit of disputing, and the profound misery or discomfort in which the mass of mankind, then even more than now, were sunk, we can hardly feel surprise or regret that a great statesman and a great philosopher should have suggested the application of man's intellectual endowments to the improvement of his material condition.

8th, Nor must we forget the hopefulness of Bacon as an important element in his influence. Men who despair of mankind and of the future are, happily, seldom successful in persuading others to accept their advice or their systems. There is a healthy instinct in man which leads him to believe that the future will be better than the past, and that the labours of the present generation will not be without their effect in improving the condition of the next. No man was ever inspired with this feeling more strongly than Bacon. He stood, like a prophet, on the verge of the promised land, bidding men leave, without regret, the desert that was behind them, and enter with joyfulness and hopefulness on the rich inheritance that was spread before them. The sixth part of the Great Instauration, to which all the rest was subservient, the philosophy itself which was to be the result of the right employment of the method, he hoped only to begin. 'The fortune of the human race,' he says, 'will give the issue;—such an issue, it may be, as in the present condition of things and of the minds of men cannot easily be conceived or imagined. For the object in view is not only the contemplative happiness, but the whole fortunes, and affairs, and powers, and works of men [40].'

9th, To all these sources of influence we must add the marvellous language in which Bacon often clothes his thoughts. His utterances

[40] Distributio Operis, ad fin.

are not infrequently marked with a grandeur and solemnity of tone, a majesty of diction, which renders it impossible to forget, and difficult even to criticise them. He speaks as one having authority, and it is impossible to resist the magic of his voice. Whenever he wishes to be emphatic, there is the true ring of genius about all that he says. Hence, perhaps, it is that there is no author, unless it be Shakspeare, who is so easily remembered or so frequently quoted. His phraseology, when most quaint, as in the case of the 'Idols' and the 'Instances,' is often most attractive to the reader and most persistent in its hold on the memory. Hence, too, perhaps, it is that there is no author so stimulating. Bacon might well be called the British Socrates. Even had his individual precepts been utterly worthless, many men must have owed their first impulse to the study of nature, or to independent investigation in general, to the terse and burning words, issuing, as it were, from the lips of an irresistible commander, with which he urges them to the work.

Such, I conceive, are the principal modes and directions in which the influence of Bacon was exercised. It would be easy to add to these, but they will readily suggest others, and the limits of this work necessarily compel me to aim at brevity rather than expansion.

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§ 15. PRESENT VALUE OF BACON'S LOGICAL WORKS.

This subject has already, to a great extent, been discussed in the latter part of the last section, and it will be unnecessary here to add much to what has there been said. The two questions, however, of Bacon's influence during the past, and the value of his works to the student at the present time, seem to be so distinct as to require separate treatment, however much they may run into each other.

The intrinsic value of Bacon's logical works to the student at the present time, apart from their historical interest, as having, to adopt the fine saying of Macaulay, 'moved the intellects which have moved the world,' may be briefly considered under two aspects. The first of these is their general effect in guarding, stimulating, and disciplining the intellect; the second is the amount of definite logical doctrine, comprised in them, which retains any permanent value.

With regard to the first point, I know no work of the same kind so stimulating to a young reader, or so likely to foster habits of

independent investigation, as the First Book of the Novum Organum. What Bacon says of Plato is pre-eminently true of himself. He was 'a man of a sublime genius, who took a view of everything as from a high rock[41].' Now to the young student I know nothing of so much importance as to be brought into contact with works of real genius, and there must be many men who recollect the transition from dry manuals of Logic to the brilliant pages of Bacon as forming one of the eras in their lives. Maxims such as these, 'Homo naturae minister et interpres,' 'Scientia et potentia humana in idem coincidunt,' 'Lucifera experimenta, non fructifera, quaerenda,' 'Recte veritas temporis filia dicitur, non auctoritatis,' 'Pessima res est errorum apotheosis,' which sparkle on almost every page, live long in the memory, and insensibly influence our whole habit of thought. This educational value of the Novum Organum has never, I think, been sufficiently pointed out, but it seems to me very real and very important. As I have already noticed under the last section, there is something about Bacon's diction, his quaintness of expression, and his power of illustration, which lays hold of the mind, and lodges itself in the memory, in a way which we hardly find paralleled in any other author, except it be Shakspeare. And what are the lessons which he thus effectually communicates? The duty of taking nothing upon trust which we can verify for ourselves, of rigidly examining our first principles, of being carefully on our guard against the various delusions arising from the peculiarities of human nature, from our various interests and pursuits, from the force of words, and from the disputes and traditions of the schools, the duty of forming our conclusions slowly and of constantly checking them by comparison with the facts of nature and life, of avoiding merely subtle and frivolous disputations, of confining our enquiries to questions of which the solution is within our power, and of subordinating all our investigations to the welfare of man and society. Now, lessons such as these, even though they be stated in a somewhat exaggerated form, are so necessary and so useful, that an author who presents them in forcible and pointed language will ever retain his interest and utility for each succeeding generation of learners.

As regards the second of these questions, the amount of definite logical teaching in Bacon's works which retains a permanent value, the answer is less easy. I cannot, however, agree with those critics who seem to think that almost all his individual precepts are either

[41] De Augm., lib. iii. cap. 4.

antiquated or worthless [42]. But, as I have expressed myself fully in the notes on the various details of Bacon's method in the order in which they occur in the text, it is unnecessary that I should here do more than make a few very brief and general remarks.

Bacon was undoubtedly inclined to underrate the syllogism, that is to say, deductive reasoning, but then we must recollect that he regarded it as his special province to bring out the other side of reasoning, the inductive branch by which general principles are established rather than applied. Nor would it be true to say that he ignored the deductive side of reasoning altogether. Whenever he saw, as he often did see, its value for the purpose of applying the truths already arrived at by induction, he seems without hesitation to have assigned it a co-ordinate rank. Witness, amongst many others, the following passages: 'Majora vero speranda a nova luce axiomatum, ex particularibus illis certa via et regula eductorum, quae rursus nova particularia indicent et designent. Neque enim in plano via sita est, sed ascendendo et descendendo; ascendendo primo ad axiomata, descendendo ad opera [43].' 'Mathematica philosophiam naturalem terminare * * * * debet [44].' The seventh of the 'reliqua auxilia intellectus' (Nov. Org. ii. 21) which were to succeed the Tables, was to be entitled 'Deductio ad Praxin.'

The charge against Bacon of having, to a certain extent, detracted from the value of his method by depreciating hypothesis and neglecting to lay down rules for its legitimate employment, must undoubtedly be admitted. But then we may plead in extenuation his admission, however inconsistent, of hypothesis ('Permissio Intellectus') in ii. 20, as also i. 106, and the gross license with which, both in his time and for some time afterwards, this procedure was employed. If Bacon is to be censured in this particular, as he undoubtedly is to be, the censure ought in all fairness to be extended to Newton as well.

The method, recommended by Bacon, of gradual ascent from particular facts, through axioms of successive degrees of generality, up to the highest generalisations of all [45], though not, as I conceive, the

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[42] Not to mention Liebig and Bacon's professed adversaries, we find even Rémusat saying (p. 254): 'Bacon n'a point rectifié ou remplacé les notions reçues qu'il condamne, ou ces conceptions scientifiques des choses, sans lesquelles toute recherche marche au hasard. Ainsi point de recette sûre, point de méthode infaillible, et le peu d'usage que l'on a fait des formes techniques d'investigation qu'il recommande en re d l'utilité fort suspecte.'

[43] Nov. Org., Bk. i. Aph. 103.

[44] Id., Aph. 96.

[45] See Nov. Org., Bk. i. Aphs. 19, 104, 105. In my note on Aph. 19, I have examined this doctrine of Bacon at some length.

method which has been usually followed by scientific investigators, or that which would be most likely to contribute to the progress of science, is, certainly, the most convenient mode of representing the laws of nature, when once established. Moreover, the successive steps which led up to, and ultimately established, the Theory of Gravitation were arrived at very nearly in this precise order. To these considerations I may add that the method proposed by Bacon has met with the approval of no less distinguished an authority than Dr. Whewell[46].

With reference to the 'Tables' which occupy the beginning of the Second Book, it must be acknowledged that, however interesting they may be in the history of Logic, and however much they may have contributed to the formulating of inductive reasoning, they are only rude exemplars of the more refined and conclusive 'Canons of Induction' which we find in the works of Sir John Herschel, Mr. Mill, and later logicians. Hence, this is a part of Bacon's Logic which is not of much intrinsic value to a student who is already familiar with recent treatises. To this consideration it may be added that the reasoning throughout this part of the Novum Organum is rendered more or less vague and obscure by the employment of the term 'Form,' instead of the more precise expressions, such as Law, Cause, Conditions, &c., by which it is now replaced.

Of far more intrinsic value to the modern student, as it seems to me, are some of the 'Praerogativae Instantiarum.' Many of the expressions there employed still form part of our logical terminology, and it would be very difficult, in many cases, to describe, more aptly and precisely than Bacon does, the nature of the reasoning involved. The scientific examples are, generally, far too numerous, and are often wrongly stated, trivial, or inappropriate, but it appears to me that less attention than it deserves has been paid to the logical matter contained in this part of Bacon's work.

The relation of Observation to Experiment and of both to the more purely rational process of Induction, is well conceived and stated by Bacon.

To the doctrine of Fallacies, or 'Idola,' I have already alluded under the first, or more general head, though it might also well be taken into account in drawing up a list of the special logical doctrines which are of intrinsic value to the modern student.

It will be seen that I am inclined to attribute to Bacon's logical

[46] See Novum Organum Renovatum, bk. ii. ch. 6, and Preface, 3rd Ed., pp. ix, x.

rules and maxims much more intrinsic value, even for the purposes of students at the present time, than is usually conceded to them, though I am not prepared to differ substantially from the judgment of M. de Rémusat: 'Ses vues générales restent la preuve la plus populaire de son génie[47].'

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§ 16. OPPONENTS OF BACON.

Under this head, I propose only to give some examples of the various grounds of opposition or disparagement to which the Baconian philosophy has been subjected, thinking that, though far from exhaustive, they will be of some interest to the reader.

Perhaps, I ought first to notice a letter from Sir Thomas Bodley (originally published in Bacon's Remains, 1648, pp. 85–87), 'to Sir Francis Bacon, about his Cogitata et Visa, wherein he declareth his opinion freely touching the same.' The writer, who has evidently a great affection for the old learning, is somewhat scandalised by Bacon's revolutionary sentiments, and thinks that if we 'come babes ad regnum naturae, as we are willed by Scriptures to come ad regnum coelorum, there is nothing more certain than that it would instantly bring us to Barbarism, and after many thousand years leave us more unprovided of theoricall furniture than we are at this present.' The letter is interesting, but it betrays bewilderment and an incapacity to understand Bacon's dissatisfaction with the existing state of things or a reform in the sciences such as he projected. It has, in recent times, been disinterred from oblivion by De Maistre and other antagonists of Bacon.

Far more pertinent is the unfavourable opinion of Bacon's philosophy expressed by Harvey, as given in Aubrey's Lives (Letters written by Eminent Persons in the Seventeenth and Eighteenth Centuries, to which are added Lives of Eminent Men by John Aubrey Esq., 1813, vol. ii. p. 381): 'He' (Harvey) 'had been physician to the Lord Ch. Bacon, whom he esteemed much for his witt and style, but would not allow him to be a great philosopher. Said he to me, "He writes philosophy like a Ld Chanceller," speaking in derision.' Harvey, however, seems to have had a peculiar dislike of the 'neoteriques,' to whom, we are told on p. 383, he once, in

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[47] Bacon, Sa Vie, &c., p. 243.

conversation with the writer, applied a very unsavoury epithet. Nor, perhaps, did he like Bacon personally; for (p. 226) 'Dr. Harvey told me his eie was like the eie of a viper.' Be this as it may, the opinion was not an unnatural nor altogether an unfair one, as expressed by a man of great eminence in a particular branch of science, of one who attempted to make all science his province. Then as now, I presume, the philosopher and the specialist were apt to misunderstand and undervalue each other.

Mr. Napier refers to a work of Alexander Ross, a voluminous author, well-known to the readers of Hudibras, entitled Arcana Microcosmi, or the Hid Secrets of Man's Body discovered; with a Refutation, amongst other books, of 'Lord Bacon's Natural History,' 1652. (The copy in the Bodleian is the Ed. of 1651, containing only the refutation of Dr. Browne's Vulgar Errors, and not that of Bacon's Sylva Sylvarum.) The author says: 'I have cursorily run over my Lord's New Philosophy,' and 'find that philosophy is like wine, the older the better to the taste.' He is specially angry with 'these new Philosophers' for having 'jumbled the predicaments so together, that their scholars can never find out the true genus of things.' Alexander Ross is a very zealous Aristotelian, and at the end of his attack on Dr. Browne, 'pities to see so many young heads, still gaping like chamelions for knowledge, and are never filled, because they feed upon airy and empty phansies; loathing the sound, solid and wholesome viands of Peripatetick wisdom, they reject Aristotle's pure Fountains, and dig to themselves cisterns that will hold no water.' 'Let us not wander then any longer with Hagar in the wild desart.' 'Let Prodigals forsake their husks, and leave them to swine.'

In Francis Osborn's Miscellany (1659), The Author to the Reader, there is a curious sentence, shewing how early the charge of Atheism was directed against Bacon. After speaking of Raleigh having been branded with the title of an Atheist, 'though a known asserter of God and providence,' the writer goes on to say: 'A like censure fell to the share of venerable Bacon, till over-balanced by a greater weight of glory from Strangers.'

Cudworth, in his Intellectual System (published in 1678), attacks Bacon for having called in question the received doctrine of Final Causes. He seems doubtful, however, what interpretation to put on his words. Thus, having spoken of 'some who have unskilfully attributed their own Properties to Inanimate Bodies,' he proceeds to say: 'Of which Fanciful Extravagances if the Advancer of Learning be understood, there is nothing to be reprehended in this following

passage of his, Incredibile est quantum agmen Idolorum Philosophiae immiserit, Naturalium Operationum ad Similitudinem Actionum Humanarum Reductio. But if that of his be extended further, to take away all Final Causes from the things of Nature, as if nothing were done therein for Ends Intended by a Higher Mind, then it is the very Spirit of Atheism and Infidelity.' For the whole discussion, see First Edition, pp. 679–683, or the Latin Translation of 1733, vol. ii. pp. 820–825 (cap. 5. §§ 61, 62). Mosheim, who points out that the allusion is to Bacon, attempts, in his note, to explain 'quare Cudworthius toties eximium huncce virum castiget, qui magnam ubique in scriptis suis supremi Numinis reverentiam et studium testatur[48].' There can be little doubt that, in his frequent attacks on the philosophy of Democritus, Cudworth also glances at Bacon. Rémusat draws attention to the circumstance that Cudworth did not combat Bacon by name. 'Par équité ou par respect, il n'en veut pas faire un adversaire de la vérité. Ainsi que Boyle dans sa défense des causes finales, Cudworth ne nomme point Bacon en soutenant les mêmes principes que Boyle, et l'usage s'est établi presque sans exception de ne pas comprendre Bacon dans les attaques dirigées contre sa doctrine. Compromettre ce nom dans la controverse serait encore aujourd'hui une sorte d'inconvenance.' Rémusat's Bacon, p. 409.

One of the most violent antagonists of Bacon and of the Royal Society (names which, in his mind, were evidently very closely connected) was Dr. Henry Stubbe; 'the most noted person of his age that these late times have produced,' says Antony Wood, who has devoted to him one of the quaintest and most amusing of his Lives[49]. Stubbe was a turn-coat alike in philosophy, religion, and politics, and was animated by more even than the usual bitterness of his class. His diatribes against Sprat, Glanvil, the Royal Society in general, and Bacon as their philosophical father, are, however virulent, too dull and rambling to be worth transcription, but specimens of them may be found in the Legends no Histories (1670), in the Plus Ultra reduced to a Non Plus (1670), The Lord Bacon's Relation of the Sweating-Sickness (1671), and An Epistolary Discourse concerning Phlebotomy (1671). He speaks repeatedly of 'these

[48] Dugald Stewart (Elements of the Philosophy of the Human Mind, Ed. Hamilton, vol. ii. pp. 337–339) has some severe remarks on Cudworth, who, he thinks, is uncandid in his treatment of Bacon. He also points out his carelessness in confounding the idola specus and the idola tribus.

[49] See Athenae Oxonienses, Ed. Bliss, vol. iii. p. 1069, &c.

Baconical Philosophers,' 'this Bacon-faced generation,' &c. (showing, by the way, pretty conclusively, the influence which was already supposed to be exercised by Bacon's philosophy), and, as a professed admirer of the old learning, somewhat inconsistently 'declares that the Lord Bacon did steal the principal parts of his Novum Organum out of Aristotle, and only disguised his Suggestions in a new Mode and Dress.' Similarly, the Advancement of Learning was stolen from Ludovicus Vivès, De causis corruptarum Artium[50]. 'The only judgment I can make of my Lord Bacon's Actings, is, that being so Flagitious, and so ignominiously degraded: He determined to redeem the Infamy of his past life by amusing the world with New Projects; and to gain a Chancellorship in Literature, when he was excluded from that on the Bench: And to revenge himself of the Nation whom he had exasperated, by diffusing Heresies in Philosophy, and creating in the Breasts of the English such a desire of Novelty, as rose up to a contempt of the Ancient Ecclesiastical and Civil Jurisdiction, and the Old Government, as well as Governours of the Realm: And the Root of all our present Distractions was planted by his hand.' See 'The Lord Bacon's Relation of the Sweating-Sickness and Defence of Phlebotomy;' 'Discourse concerning Phlebotomy,' Preface to the Reader. Abundance of evidence shewing Bacon's influence on the 'Bacon-faced generation' is supplied in this diatribe. Thus, 'We acknowledge no Chancellors of Philosophy, Philology, Medicine, &c.' 'No Law ever made him our Dictator, nor is there any Reason that concludes him infallible.' 'Let these insulse Adherents of his buy some salt, and make use of more than one grain, when they read him.' Elsewhere, Stubbe informs his readers that it is only out of his regard to Physic, Religion, and Education, that he is led to intermeddle in 'Natural Philosophy,' or the disputes of these 'Experimental Philosophers.'

Passing to the middle of the eighteenth century, when Bacon was at the zenith of his glory, we find the chorus of approbation broken by the modified praise rather than the disparagement of Hume. The weapon which Hume wielded, comparison with philosophers who have made positive contributions to science, is one which has since

[50] Having occasion to compare a remedy against the Sweating-sickness given by Holinshed the Chronicler with one given by Bacon, he says: 'The works of the former will be much more valued than the latter by our nation, as long as they have any judgment. The truth is the Lord Bacon is like great piles; when the Sun is not high, they cast an extraordinary shadow over the earth, which lesseneth as the Sun grows verticall.' Legends no Histories, pp. 27, 28.

been frequently used with effect[51]. I shall give the passage in full, but, as the various topics have all been discussed in previous sections, I shall here make no comment upon it.

'The great glory of literature in this island, during the reign of James, was Lord Bacon. Most of his performances were composed in Latin; though he possessed neither the elegance of that, nor of his native tongue. If we consider the variety of talents displayed by this man, as a public speaker, a man of business, a wit, a courtier, a companion, an author, a philosopher, he is justly the object of great admiration. If we consider him merely as an author and philosopher, the light in which we view him at present, though very estimable, he was yet inferior to his cotemporary Galileo, perhaps even to Kepler. Bacon pointed out at a distance the road to true philosophy: Galileo both pointed it out to others, and made himself considerable advances in it. The Englishman was ignorant of geometry: the Florentine revived that science, excelled in it, and was the first that applied it, together with experiment, to natural philosophy. The former rejected, with the most positive disdain, the system of Copernicus: the latter fortified it with new proofs, derived both from reason and the senses. Bacon's style is stiff and rigid: his wit, though often brilliant, is also often unnatural and far-fetched; and he seems to be the original of those pointed similes and long-spun allegories, which so much distinguish the English authors: Galileo is a lively and agreeable, though somewhat a prolix, writer. But Italy, not united in any single government, and perhaps satiated with that literary glory which it has possessed both in ancient and modern times, has too much neglected the renown which it has acquired, by giving birth to so great a man. That national spirit which prevails among the English, and which forms their great happiness, is the cause why they bestow on all their eminent writers, and on Bacon among the rest, such praises and acclamations, as may often appear partial and excessive[52].'

The excessive praise bestowed on Bacon by Voltaire and the Encyclopedists, though met at first by the argument that they did not truly represent the views of Bacon, at last provoked a violent reaction, to which the well-known work of Count Joseph de Maistre gave expression. This work, entitled Examen de la Philosophie de Bacon, was published posthumously at Paris and Lyons in 1836,

[51] Besides the works mentioned in this section, see the article on Galileo by M. Biot in the Biographie Universelle.

[52] Hume's History of England, Appendix to the Reign of James I.

and has been re-published at least once. To De Maistre Bacon is, above all things, an atheist, who aggravated his atheism by hypocrisy. But he is also a mere pretender to philosophy and science, a charlatan, an impostor. He contributed nothing to science himself, and it is a mere delusion to suppose that his philosophy has in any way helped to form those who have done so. It is true that he preaches science, but, like his Church, when it preaches Christianity, he preaches without a mission. 'Sa philosophie ressemble à sa religion, qui proteste continuellement: elle est entièrement négative et ne songe qu'à contredire.' To Bacon, as its ultimate source, is due all the atheism, the materialism, the sensualism, the libertinism of the untoward generation which had just passed away in France. 'On voit que Locke est successeur de Bacon (ce qui est incontestable); on voit que Locke à son tour engendra Helvétius, et que tous ces ennemis du genre humain réunis, y compris Cabanis lui-même, descendent de Bacon[53].' With regard to individual works, the De Augmentis is 'parfaitement nul et méprisable;' the Novum Organum is far more condemnable still, for, independently of the individual errors with which it swarms, the general aim of the work renders it worthy of Bedlam ('le rend digne d'un Bedlam'). Towards the end of this tirade (one of the greatest compliments, perhaps, which Bacon has ever received), the author appears for a while to relent, but he soon recovers himself: 'La nature l'avoit créé bel esprit, moraliste sensé et ingénieux, écrivain élégant, avec je ne sais quelle veine poétique[54] qui lui fournit sans cesse une foule d'images extrêmement heureuses, de manière que ses écrits, comme fables, sont encore très amusans. Tel est son mérite réel, qu'il faut bien se garder de méconnaître; mais dès qu'on le sort du cercle assez rétréci de ses véritables talens, c'est l'esprit le plus faux, le plus détestable raisonneur, le plus terrible ennemi de la science qui ait jamais existé. Que si on veut louer en lui un amant passionné des sciences, j'y consens encore; mais c'est l'eunuque amoureux[55].'

De Maistre was a furious, though an ingenious, fanatic. We now come to the attacks of Brewster, Lasson, and Liebig, which, either from their intrinsic merit or from the position of their authors, require

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[53] 1st Ed., vol. ii. p. 338.

[54] In vol. i. p. 5, De Maistre makes what appears to me to be a very true criticism on Bacon: 'rarement il résiste à l'envie d'être poète.' There is a certain amount of truth too in the disparaging criticism which follows: 'L'image se présente avant tout à son esprit, et le contente.'

[55] Vol. ii. pp. 364, 365.

more serious notice. As, however, the topics which they start are, for the most part, dealt with elsewhere, either in the Introduction or in the notes to this Edition, I shall here confine myself to a very brief notice of them.

In his Life of Newton (1855)[56], Sir D. Brewster, irritated apparently by the injudicious statement of 'some modern writers of celebrity,' that Newton 'owed all his discoveries to the application of the principles of Bacon,' maintains a proposition equally extreme, and, as it seems to me, equally untrue, that he did not 'derive the slightest advantage from Bacon's precepts.' For what I conceive to be a refutation of this position, I must refer the reader back to what I have already said on the relation of Newton to Bacon[57]. Taking occasion of this incidental mention of Bacon, Brewster goes on to combat his claims generally as a reformer of science. He argues, or rather asserts (for, except of the first proposition, he adduces hardly any proof): 1st, that 'the necessity of experimental research, and of advancing gradually from the study of facts to the determination of their cause, is a doctrine which was not only inculcated, but successfully followed by preceding philosophers;' 2nd, that no testimonies to the value of Bacon's method have been offered by those who have actually cultivated science; 3rd, that, as regards his own investigation into the nature of heat, 'the oracle which he had himself established refused to give its responses, and the ministering priest was driven with discomfiture from his shrine;' 4th, that 'a collection of scientific facts are of themselves incapable of leading to discovery, unless they contain the predominating fact or relation in which the discovery mainly resides.' Briefly to reply to these assertions, the first is, within certain limits and with certain explanations, which, however, require to be given, undoubtedly true; the second I conceive that I have already abundantly disproved; as to the third, I believe that the 'ministering priest' obtained a far more luminous answer than oracles are usually in the habit of giving; with regard to the last, if Sir D. Brewster means that a mere collection of facts, without any play of the mind upon them ('permissio intellectus,' as Bacon phrased it, or, as we should say in technical language, formation of hypotheses), is seldom or never likely to lead to discovery, I cordially agree with him, but then Bacon himself, we must recollect, was happily inconsistent on this point. Brief as is Sir D. Brewster's notice of Bacon, it deserves considerable attention, because

[56] See vol. ii. pp. 400–406.

[57] See pp. 119–124.

his objections anticipated, if indeed they did not suggest, some of the leading criticisms in the two works which follow.

Lasson's monograph on Bacon (Gustav Lange, Berlin, 1860) appeared in the Jahresbericht über die Louisenstädtische Realschule. Though it only extends over thirty-two pages, it is the weightiest of the attacks upon Bacon which I have seen. It is written not only with more moderation, but with more knowledge of Bacon's writings, and with more sympathy with the philosophical spirit in its relation to science, than is the violent diatribe of Liebig, to be next noticed. The writer dwells with much emphasis on the scientific progress which had been already made in Bacon's time, and maintains that the reformation of science was not the work of a single man, but the gradual product of the age. Moreover, the necessity of Induction, the appeal to Observation and Experiment, and the practical aims which should be kept in view in scientific enquiry, had been insisted on by a host of writers before Bacon gave utterance to them. Having, thus, combated Bacon's claim to originality, he next proceeds to an examination of his system. Here, he finds special fault with his mechanical theory of induction, the manner in which he ignores the activity of the Understanding (Verstandesthätigkeit), his criticism of Final Causes, his conception of Forms, his neglect of quantitative relations, &c. Lasson, like Liebig, is especially severe on the Sylva Sylvarum, which he says might have been more appropriately written in the eleventh than in the seventeenth century. Finally, he puts the question, 'Was Bacon really a Philosopher,' and he answers that, in the proper sense of the word, he was not; he was a genius, but, at the same time, a Dilettante (ein geistreicher Dilettant). 'Es lässt sich die Frage stellen, ob er überhaupt ein Philosoph gewesen, und wir denken, die Frage beantwortet sich von selbst in negativem Sinne, wenn man nicht das Wort Philosophie in ungebührlich weitem Sinne fasst. Aus allgemeinen Gesichtspunkten raisonniren ist noch nicht philosophiren. * * * * * In allem diesem kritischen Hochmuth, wie in der dogmatischen Zuversicht und in dem Unvermögen, Positives zu schaffen, ist Baco ein rechter Vertreter der grossen Masse, des ganz unwissenschaftlichen Bewusstseins. * * * * * Baco ist ein geistreicher Dilettant, er hat etwas von Cicero und von Voltaire. Der berühmte Harvey hat mit Recht von ihm gesagt: er schreibe über Philosophie, wie ein Lord-kanzler.' That Bacon, however, did great service in spreading a taste for experimental enquiry and in drawing the popular attention to the importance of consulting facts, is allowed throughout the enquiry.

Liebig's onslaught on Bacon (Ueber Francis Bacon von Verulam) appeared both in German and in English in 1863, and was followed by a keen controversy between Liebig and Sigwart. (See the next section, on the Bibliography of the Novum Organum.) The occasion of this work was Liebig's annoyance at the rejection of some of his chemical theories by English agriculturists. Their singular obstinacy must, he thought, be due to some inherent defect in the English mind, and this suspicion led him to the study of the English philosophers. When, at last, he came to the works of Bacon, all was clear. These furnished, if not the source, at least the typical example of the methods of experiment and reasoning common amongst the English dilettanti, who had had the temerity to reject his theories. The study of Bacon thus acquired the charm of a scientific discovery; the writer, he tells us, went much deeper than before into the subject, and, hence, the work before us (see Preface to German Edition).

I have no hesitation in saying that this work, which is extremely bitter in tone, and often very inaccurate, contributes nothing to the knowledge or appreciation of Bacon's philosophy. It repeats the thread-bare arguments employed by Brewster and Lasson, but with an amount of exaggeration and asperity which is utterly foreign to the second, and would, I think, have been distasteful even to the first of these writers. The author is, at times, almost as violent as De Maistre or Stubbe. Thus (I quote from the English text): 'Bacon is conscious that in most instances he is not truthful, and has the prudence to blunt the weapons of his adversaries beforehand;' 'Vain self-praise and detraction of others' merit go always hand in hand with his lordship, just as with other vulgar specimens of humanity;' 'When a boy, he studied jugglery, and his cleverest trick of all, that of deceiving the world, was quite successful;' 'Nature, that had endowed him so richly with her best gifts, had denied him all sense for truth;' he is the type 'of the scientific nut-cracker or the dining philosopher, which, under James I, became the fashion [58];' his scientific investiga-

[58] In one of the numbers of the Allgemeine Zeitung (Nov. 7, 1863), Liebig waxes still more wroth. After describing Bacon's work as a caricature of the scientific movement of the sixteenth century, and Bacon as following in the path of science like a shadow, as parodying the calm and clear image of truth by his burlesque contorsions, he compares him successively with a news-hawker, an ape in soldier's-clothes, and a grinder of scientific instruments, who is unconscious of their use. Truly, not only are the sins of the fathers visited upon the children, but those of the children upon the fathers! Little can Bacon have anticipated the penalty he would have to pay for the unenlightened obstinacy of English farmers in the nineteenth century!

tions were carried on for the sake of reward; the 'Historia Vitae et Mortis' was written with the view of augmenting his influence over the King, and was 'intended to justify the inclination of certain persons about the court for the pleasures of the table, as well as other appetites, and to diminish their fear of death.' Notwithstanding all these aspersions, we are told at the end of the article that 'we must not forget that Bacon, above all others, saw and comprehended the value and the importance of natural science for the purposes of life,' while 'Bacon's Essays are unexceptionable documents testifying of his genius and sagacity, as well as of his profound knowledge and correct appreciation of human relations and the different conditions of men [59].'

Both Liebig and Lasson lay considerable stress on the crude character of many of the observations and experiments recorded in the Sylva Sylvarum. It is only fair, therefore, to Bacon's memory to quote what is said by Rawley in his introduction to that work [60]. 'I have heard his lordship often say, that if he should have served the glory of his own name, he had been better not to have published this Natural History; for it may seem an indigested heap of particulars, and cannot have that lustre which books cast into methods have; but that he resolved to prefer the good of men, and that which might best secure it, before anything that might have relation to himself.' 'And I have heard his lordship speak complainingly, that his lordship (who thinketh he deserveth to be an architect in this building) should be forced to be a workman and a labourer, and to dig the clay and burn the brick; and more than that, (according to the hard condition of the Israelites at the latter end) to gather the straw and stubble over all the fields to burn the bricks withal.' Nor is the Sylva Sylvarum so contemptible as Bacon's adversaries represent it to be. It is probably far the best and most complete single collection of the kind that, up to that time, had been published.

Even Liebig is almost outdone by his French translator, M. de Tchihatchef (Lord Bacon, Paris, 2nd Ed. 1877). The following may serve as choice examples of the indignation which Bacon arouses in the breast of this modern philosopher [61]. 'Paracelse était presque

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[59] See Macmillan's Magazine for July and August, 1863.

[60] E. and S., vol. ii. pp. 335-337.

[61] M. de Tchihatchef has a wonderful faculty of blundering. The following is such an amusing instance that I cannot refrain from giving it. Sir Henry Savile, in the course of lectures which, as first occupant of one of his own chairs, he gave in Oxford, concluded by saying: 'Exsolvi, per Dei gratiam, Domini Auditores,

aussi vaniteux, aussi fanfaron, aussi boursoufflé que Bacon; mais ce qui établit une différence,' &c. (Préface du Traducteur, p. xxv.) 'Après de telles preuves, il est donc permis de dire maintenant que le rôle de Bacon, dans l'histoire des sciences d'observation, fut à peu près celui de Julien l'Apostat dans l'histoire du christianisme, et que la seule place vraiment saillante qu'il occupera dorénevant dans les fastes du passé est celle du plus hardi et surtout du plus heureux des mystificateurs connus; à ce titre il brillera, en les effaçant, au-dessus du comte de Saint-Germain et de Cagliostro.' (Id. p. xxiii.)

These various accusations against Bacon or his philosophy, when we state them in brief, resolve themselves into the following: 1st, he was an atheist; 2nd, he was a plagiarist; 3rd, he was a smatterer; 4th, his works have had no influence in the subsequent progress of science; 5th, his proposed methods of investigation are defective, if not false, in statement, and inapplicable in practice. As these different charges are discussed, and my own opinion on them stated, in other parts of the Introduction, it is unnecessary that I should say anything further on them in this place.

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§ 17. BIBLIOGRAPHY OF THE NOVUM ORGANUM.

Though the first Edition of the Novum Organum did not appear till the year 1620, we are informed by Dr. Rawley (in the Life of Bacon, prefixed to the Resuscitatio) that he had himself seen at least twelve revisions of the work, 'revised year by year, one after another; and every year altered and amended in the frame thereof[62].' If this

promissum, liberavi fidem meam, explicavi pro meo modulo definitiones, petitiones, communes sententias, et octo priores propositiones Elementorum Euclidis. Hic annis fessus, cyclos artemque repono.' (Praelectiones &c., Oxonii, 1621.) Dugald Stewart somewhere adduces these words as a proof, if I recollect rightly, of the prolix and elementary teaching of the time, and from him probably (or from Malebranche, who also refers to them as affording an example of the abuse of the commentatorial spirit, De la Recherche de la Vérité, livre ii. 2me partie, ch. 7), though with some slight exaggeration, Liebig borrows the story. But his translator, having never probably heard of Sir Henry Savile, and, either being very careless or having a very imperfect knowledge of the German language, alludes to this anecdote as illustrating the character of the lectures given at this time 'à Séville et à Oxford'!

[62] Cp. the Auctoris Vita, prefixed to the Opuscula Varia posthuma, published in 1658: 'Ipse reperi in archivis Dominationis suae autographa plus minus duodecim *Organi novi*, de anno in annum elaborati et ad incudem revocati; et singulis annis ulteriore lima subinde politi et castigati.'

story be accurate, the original composition of the Novum Organum would be carried back to the year 1608. But the substance of the First Book is to be found in a work composed at a still earlier period, the Cogitata et Visa (E. and S., vol. iii. pp. 587–620). This work, though not published till long after Bacon's death (by Gruter in 1653), must have been composed as early as the summer or autumn of 1607, as, in that and the early part of the following year, it is the subject of a correspondence between Bacon and Sir Thomas Bodley (Spedding's Life and Letters of Bacon, vol. iii. pp. 365, 366)[63]. Still earlier, but standing in much less close relation with the First Book of the Novum Organum, as it now exists, is the Partis Secundae Delineatio (E. and S., vol. iii. pp. 541–585), which Mr. Spedding refers to the year 1606 or 1607. For an account of this, however, and other preliminary drafts of portions of the Novum Organum, the student must be referred back to § 3 of this Introduction.

The so-called Second Edition of the Novum Organum is a small duodecimo, published at Amsterdam in 1660, but, between this and the First Edition, there were copies published at Leyden in 1645 and 1650[64]. Except in editions of the Complete Works or the philosophical works of Bacon, I cannot find any Latin Edition of the Novum Organum between the year 1660 and the Würzburg Edition of 1780[65]. One appeared at Glasgow in 1803, and another was issued by the Clarendon Press in 1813. Since that time, Mr. Kitchin's and other annotated Editions, to be mentioned below, have made the work, in its separate form, easily procurable.

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[63] A very beautiful manuscript of this work, corrected in Bacon's own handwriting (a fact which is not only vouched for by Mr. Spedding, but which I have verified by comparison with a letter in the Bodleian written by Bacon to the King, April 21, 1621), exists in Queen's College Library, Oxford.

[64] Bouillet speaks of an Edition, published at Leyden in 1652. I can find no other trace of this Edition, and think that he must have mistaken for an edition of the Novum Organum one of the De Augmentis published at Leyden in that year. His bibliographical account, generally, is not very accurate. Thus, the Ed. of 1650 (which, like that of 1645, was published by Adr. Wingaerde) is called an Elzevir.

In 1638, a little 12mo volume was issued at Leyden, entitled Francisci de Verulamio Historia Naturalis et Experimentalis De Ventis, &c., containing, in addition to the Historia Ventorum and other matter, Nov. Org. ii. 11–20 ('De Forma Calidi'), ii. 48 ('De Motus sive Virtutis Activae Variis Speciebus'), and the Instantia Crucis on the Tides from ii. 36. In the British Museum, there are reprints of this volume in 1648 and 1662. It was translated by R. G. Gent, London, 1653.

[65] Watt (Bibliotheca Britannica) speaks of an edition in folio, published at London in 1677, but, as I can find no other trace of this edition, I suppose he must refer to the Epitome by M. D. in English, to be noticed presently.

Of English Translations of the Novum Organum, Peter Shaw's (which has been frequently reprinted) first appeared in 1725, in his English Edition of Bacon's works. One made by Mr. W. Wood was embodied in Montagu's Edition (London, Pickering, 1831), and re-printed by Pickering in a separate form in 1844, and, again, in Bohn's Series (Ed. Devey), 1853. A translation of the First Book only was printed for private circulation by Mr. Glassford, Edinburgh, 1844. Mr. Kitchin's Translation appeared in 1855 (Oxford Clarendon Press), Mr. Headlam's in the 4th vol. of Ellis and Spedding's Edition, 1858, and, lastly, Mr. Andrew Johnson's (Bell and Daldy) in 1859.

It should be noticed that an English epitome of the Novum Organum 'translated and taken out of the Latin by M.D. B.D.' was published in 1676 at the end of the tenth Edition of the Sylva Sylvarum, and was reprinted in the subsequent editions of that work.

Of published French Translations, I can speak, from personal inspection[66], only of those of Lasalle (Œuvres de François Bacon, Chancellier d'Angleterre, traduites par A. Lasalle, Dijon, An 8 [1800]), and of M. Lorquet, which contains only Book i. and portions of Book ii. The latter work, which is bound up with extracts from Descartes and Leibnitz, is an Ouvrage autorisé par la conseil royal de l'instruction, and was published at Paris in 1847.

In the Panthéon Littéraire, there is a collection of the Œuvres Philosophiques, Morales, et Politiques de François Bacon in French by J. A. C. Buchon, Paris, Desrez, 1838. The translation of the Novum Organum is taken from Lasalle. The same translation re-appears, with occasional corrections, and a few meagre notes, in the less complete collection of the Œuvres de Bacon, Traduction revue, corrigée, &c., by F. Riaux, 2 vols. Paris, 1843[67].

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[66] M. Bouillet refers to a work entitled 'Fragmens extraits des œuvres du chancellier Bacon, traduits de l'édition anglaise de P. Shaw,' by Mary Dumoulin, Paris and Amsterdam, 1765, but I have not been able to find this book even in the Bibliothèque Nationale. It seems, amongst other things, to contain a good analysis of the Novum Organum. See Bouillet, tome ii. Introd., p. lii.

[67] During a recent visit to the Bibliothèque Nationale in Paris, I found an old French translation in MS. of portions of the Novum Organum, contemporary, I believe, or almost contemporary with the original publication of the work. It is written in a beautiful hand, very similar to much of the writing which I have seen in MSS. of Bacon's own time, and not likely, M. Deprez, one of the gentlemen attached to the Manuscript Department, informed me, to be later than the early part of the seventeenth century. This MS., which is numbered Fr. 19,092, formerly belonged to the Coislin Collection and subsequently to the Library of St. Germain des Prés. The description of it in the Catalogue is as follows: 'Ex Bibliotheca MSS. Coisliniana,

The best German translation, I believe, is Franz Baco's Neues Organon, Uebersetzt, erlaütert, &c., von J. H. von Kirchmann. Berlin, 1870 (published in Kirchmann's Philosophische Bibliothek). Previous German translations are those of Bartholdy (1st Book only), 1793; and of Brück, 1830.

I have seen an Italian translation (anonymous) published at Bassano in 1788: Nuovo Organo delle Scienze di Francesco Bacone, &c. Traduzione in Italiano, con Annotazioni, &c. Whether there is any more recent translation, I am not aware.

In the Leipsic edition of the Novum Organum, 1839, a Portuguese translation of the Obras philosophicas, by Jac. de Castro Sarmento, is mentioned as having been published in London, with notes, in 3 vols. 4to., in 1731.

At Cracow in 1834, there was published a book entitled Bakona Metoda Tlumaczenia Natury (the Baconian Method of interpreting Nature), by Michal Wiszniewski.

There is a Sanskrit version of the Novum Organum, published by order of the Government of the N. W. provinces, for the use of the Benares Sanskrit College, and prepared by Paṇḍit Viṭṭhala S'Aśtrí, Benares, 1852. The materials for this version were published in a separate form by J. A. Ballantyne at Mirzapore in 1852. 'Each

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olim Segueriana, quam Illustr. Henricus Du Cambout, Dux de Coislin, Par Franciae, Episcopus Metensis, &c., Monasterio S. Germani a Pratis legavit. An. MDCC. xxxii.' In the Catalogue of Séguier's Collection of MSS. (Paris, 1686), this MS. is not mentioned.

The piece is entitled Méthodes et conceptions du sieur Verulam, Chan^er d'Angleterre, and begins 'Tableau des belles et rares conceptions de Messire françois Verulam Chan^er de la grand Bretagne touchants le restablissemen des sciences et l'exp^on de la méthode.' It then proceeds much as in the opening words of the Great Instauration. The order of the pieces in the 1st Edition is followed throughout, including the Deest Pars Prima, &c., which, so far as I am aware, occurs in no other edition of the seventeenth or eighteenth centuries. The translation of the 1st Book leaves off at the beginning of the 101st Aphorism, a space being left for the insertion of that and the remaining Aphorisms of the 1st Book. The 2nd Book is translated as far as the words 'de forma calidi' in Aph. 11, just before the commencement of the Tables. There are no blank leaves after this.

This translation is not, so far as I can ascertain, mentioned by any writer on Bacon, and the translations of Lasalle and Lorquet bear no signs of its having been consulted by those authors.

I am inclined to suspect that this translation may have been made by J. Baudoin, who published translations of so many other works of Bacon, and who, as appears from the 'Privilége du Roy,' prefixed to his Aphorismes du Droit, had by him a stock of translations from Bacon, which he contemplated publishing from time to time.

sentence has been written with the view of being hereafter rendered into Sanskrit, in order to its eventual reproduction in all the derivative modern languages of India.'

The first attempt at editing the complete works of Bacon was made by J. B. Schönwetter and J. Gruter, in their edition in Latin, issued at Frankfort on the Main in 1665[68]. The Latin Works were published by Wettstein at Amsterdam in 1684, and reprinted in 1695 and 1730. There was an edition of the Opera Omnia 'opera Simonis Johannis Arnoldi' at Leipsic in 1694. An edition in 4 vols. was issued by J. Blackbourne at London, in 1730. There was a handsome Edition, with a life by Mallet, issued in 1740, and this was followed with tolerable rapidity by several others. Finally, we have Basil Montagu's edition, Pickering, 1825—1836, and the truly valuable and splendid edition of Ellis, Spedding, and Heath, Longmans, 1857, &c. Bouillet's Edition of the Philosophical Works will be noticed below.

The following are the principal works on Bacon's philosophy in general or the Novum Organum in particular, which have fallen under my notice. I omit merely popular lectures, or chapters in Histories of Philosophy, some of the latter of which, however, such, for instance, as those of Brucker, Lewes, Ueberweg, &c., are of considerable merit. On the other hand, I insert short notices of the Baconian Philosophy, which would otherwise be likely to escape the reader's attention.

Voltaire. Lettres sur les Anglois. Lettre XII. About 1728. This is reproduced, with additions, in the Dictionnaire Philosophique.

Encyclopédie began to appear in 1751. Discours Préliminaire, pp. 24, 25, and Article on Bacon.

Analyse de la Philosophie du Chancellier François Bacon, avec sa vie, &c. par A. Deleyre. Amsterdam and Paris, 1755; Leyden, 1756. Only a small portion of this work refers to the Baconian philosophy properly so called, but in the Preface to the work Le Christianisme &c., noticed below, the author says that Bacon is hardly known to the majority of men of letters in France, except through this Analysis of his Philosophy. The book was published anonymously.

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[68] Bouillet speaks of a collection of the Latin works of Bacon, edited by Rawley, which appeared at Amsterdam in 6 vols. in 1663. It is difficult to suppose that he is altogether mistaken, but I can find no other mention of this edition, though I have made diligent search both in books and catalogues.

Bouillet refers to an Essay on the Philosophy of Bacon by Ulrich, Berlin, 1780.

In the Encyclopédie Méthodique, Philosophie Ancienne et Moderne, there is a long article on 'Baconisme,' signed by M. Naigeon, giving a classified account of Bacon's opinions on various topics. This article, in which the author follows the estimate of Bacon taken by the Encyclopedists, appeared in 1791. It incorporates most of Deleyre's Analysis.

Le Sage, in a long letter in the Bibliothèque Britannique, Sciences et Arts, tome ix, Geneva, 1798, brings together a number of quotations from Bacon, for the purpose of shewing that he did not reject the enquiry into the general causes of phenomena. In tome viii. of the same series, there is a letter by Le Sage, not expressly written on Bacon, but occasionally alluding to or quoting him. Neither of these articles, however, seems to correspond with the one referred to by Rémusat (p. 392), as contained in tome viii.

Le Christianisme de François Bacon &c. Nyon, Paris, An 7 (1799). 2 vols. This work was written by the Abbé J. A. Émery, but published anonymously. Its object is to vindicate the Christianity of Bacon against the Encyclopedists.

Lasalle, noticed above.

Bacon. Tel qu'il est. Berlin, 1800 (a Pamphlet). Précis de la Philosophie de Bacon. Paris, 1802, 2 vols. Both these works are by J. A. De Luc, and are directed against Lasalle, who had written with a strong pre-disposition to find in Bacon the philosophical and theological principles of the Revolution. De Luc refers to the Abbé Émery's work, Le Christianisme, &c. It may be noticed that Lasalle had omitted all those passages in Bacon's works which appeared to have a religious tendency, calling them contemptuously 'les *oremus*.'

Dugald Stewart's Preliminary Dissertation, Part i. ch. 2. This first appeared in 1815.

Review of Stewart's Dissertation, Quarterly Review, No. 33, 1817.

Basil Montagu's Review of the Novum Organum in the Retrospective Review, vols. 3 and 4, 1821.

Playfair's Preliminary Dissertation, 1824. Both this and Stewart's Dissertation are prefixed to the Encyclopaedia Britannica. From Professor Playfair I find that many subsequent writers borrow, with or without acknowledgement. His remarks and illustrations are of peculiar value to an Editor of the Novum Organum.

Destutt de Tracy, Elemens d'Idéologie, De la Logique, 1826. See Discours Préliminaire and Sommaire Raisonné de l'Instauratio

Magna. [Though the author criticises severely the details of Bacon's method, he follows the Encyclopedists in exaggerating the reform which Bacon effected. Thus (tome i. p. 380) he says: 'Aussi l'art logique a-t-il été complètement erroné jusqu'à Bacon.' Of his own time, De Tracy says: 'Bacon est encore un de ces auteurs beaucoup plus cités que lus, et beaucoup plus lus qu'entendus.']

Dr. Hippus' Account of the Novum Organum, published, in two parts, in the Library of Useful Knowledge, 1827, 1828. Much of this tract is borrowed from Playfair.

Sir John Herschel's Discourse on the Study of Natural Philosophy, published in Lardner's Cabinet Cyclopaedia, 1831.

Histoire de la Vie et des Ouvrages de François Bacon, par J. B. De Vanzelles. Paris, Levrault, 1833. [M. de Vanzelles promised a translation of the Works, but this, I believe, never appeared.]

Œuvres Philosophiques de Bacon; avec Notice, Sommaires, et Éclaircissemens, par M. N. Bouillet, Paris, Hachette, 1834–5. This work (in three large volumes) is highly praised by Mr. Ellis and is founded, throughout, on a conscientious comparison of Bacon's various writings. It is now out of print. The notes are somewhat meagre, but it is furnished with valuable Introductions, Summaries, &c.

De Maistre. Examen de la Philosophie de Bacon. 2 vols. Paris and Lyons, 1836; republished 1852. [This is a violent attack on Bacon from an Ultramontane point of view.]

Macaulay's Essay on Bacon, 1837. Published in the July number of the Edinburgh Review. [Notwithstanding its many defects and misconceptions, this brilliant Essay deserves an important place in an enumeration of Baconian literature, as having done much to revive the popular interest in Bacon's life and works.]

De Baconis Verulamii Philosophia Dissertatio Academica, Parisiis, 1838. (An exercise for the Doctor's Degree by F. Huet.)

Hallam's History of Literature, Part iii. ch. 3. This first appeared in 1839.

F. Baconi de Verulamio Novum Organum, opus diu integris suis partibus desideratum, in usum Juventutis Academicae. Lipsiae, 1839-40. This edition has most copious indices, and is furnished with a long 'Propylaeum' by C. G. M. Janj.

Whewell's Philosophy of the Inductive Sciences (or, in the more recent form of that work, the Philosophy of Discovery). 1840.

[The reader will not fail to remark how very rich the decade 1830-40 is in works on Bacon].

De Vita et Philosophia Francisci Baconi Philosophi (an exer-

cise for the Doctor's Degree) by Gerrit Wilhelmy. Groningen, 1843.

Craik (G. L.), Bacon, his Writings and Philosophy. 3 vols. 1844.

Moffett (F. W.), Selections from the Philosophical Works of Bacon, with notes, &c. Dublin, 1847.

De Gerando, Histoire Comparée des Systèmes de Philosophie, 2me Ed., tome vi. ch. 10. (This part of the work, 'Philosophie Moderne,' was first published in 1847.) Rémusat (whose work will be noticed below) is evidently much indebted to De Gerando.

A Discourse of the Baconian Philosophy, by Samuel Tyler of the Maryland Bar. 2nd Ed. New York, 1850. [I do not know the date of the 1st Ed. The author's object is to show that 'the Baconian philosophy is emphatically the philosophy of Protestantism.' He thinks that, 'when we see how universally the a priori method has led to error, it would almost appear as though that method were the very Organon of Satan.']

Extraits du Novum Organum, &c., précédée d'une Introduction, &c., par Emile Burnouf. Paris, 1850.

Essay on Lord Bacon by Macvey Napier. Macmillan, 1853. [This work contains much useful historical information as to the reception of the Novum Organum, the opposition to it, &c. It was originally read before the Royal Society of Edinburgh in 1818, and published in their Transactions.]

English Edition of the De Augmentis and Novum Organum in Bohn's Series, by Joseph Devey. 1853.

Parallel between Roger Bacon and Francis Bacon in Pouchet's Histoire des Sciences Naturelles au Moyen Age (pp. 363-369). Paris, 1853.

Esprit et Méthode de Bacon en Philosophie, par G. A. Patru. Paris and Grenoble, 1854.

Edition of the Novum Organum, with notes, by the Rev. G. W. Kitchin. Oxford, Clarendon Press, 1855. [This edition, which has been of great assistance to the present Editor, is frequently referred to in the notes. See also Preface.]

Edition of the Novum Organum, with English notes, by the Rev. J. A. Brewer. London, 1856. [Privately printed for the use of students of King's College, London.]

Fischer (Kuno), Franz Baco von Verulam. Die Realphilosophie und ihr Zeitalter. Leipzig, 1856. Of this work an English translation was published by John Oxenford, London, 1857. The original

work has also been recently re-published, with considerable extensions and under a new title: Francis Bacon und Seine Nachfolger; Entwicklungsgeschichte der Erfahrungsphilosophie. Leipzig, 1875. [This work is of great importance in the study of the Baconian philosophy, and of peculiar interest as containing so favourable an estimate of Bacon from a foreign writer, belonging himself to a very different school of thought.]

Bacon, Sa Vie, Son Temps, Sa Philosophie, et Son Influence jusqu'à nos jours par Charles de Rémusat. Paris, 1857. [This work, like the last, should be diligently perused by every student of Bacon. M. de Rémusat attempts especially to bring out an ideal side in the Baconian philosophy.]

The magnificent edition of Bacon's works by Ellis, Spedding, and Heath. The 1st vol., containing the Novum Organum and De Augmentis, appeared in 1857. No student of Bacon's philosophy can now dispense with the five volumes, containing the Philosophical Works with prefaces and notes, to which such frequent reference is made in the subsequent pages of this edition.

Ueber Baco's von Verulam wissenschaftliche Principien von A. Lasson. Berlin, 1860. [This short tract is, to my mind, the most effective of all the attacks on the Baconian philosophy. It must, I think, have suggested to Liebig the onslaught which he made three years subsequently, but it is far more moderate and elevated in tone than is his diatribe, and shews a far more intimate acquaintance both with Bacon's doctrines and with the history of philosophy in general.]

Ueber Francis Bacon von Verulam und die Methode der Naturforschung, von Justus von Liebig. München, 1863. [This disquisition is written in a tone of shrill invective, almost as if Bacon were a personal enemy of the writer. Liebig was himself so well satisfied with his performance, that he published it also in an English form, in Macmillan's Magazine (July and August, 1863). It has been translated into French, and published with some notes and additions, by M. De Tchihatchef, Paris, 1866 (2me Ed., 1877).]

A large part of Franchi's Letture su la Storia della Filosofia Moderna, Milano, 1863, is devoted to Bacon. [The estimate of him as a reformer of method and science is, on the whole, unfavourable.]

Liebig's work produced a lively controversy in Germany. He was answered by Heinrich Böhmer, in a work entitled Ueber Francis Bacon von Verulam, &c., Erlangen, 1864; and also by Sigwart of Tübingen. Sigwart attacked Liebig's work in the Preussische

Jahrbücher of 1863, S. 93, &c. To this Liebig replied in the Allgemeine Zeitung, Nov. 2–7. Sigwart made his rejoinder in the Preussische Jahrbücher of 1864, S. 79, &c. Liebig again replied in Allg. Zeit., March 4–7. M. De Tchihatchef has translated Liebig's papers in his 'Lord Bacon,' &c., but they add little of what is new to the original pamphlet.

A similar and independent controversy, though on a much smaller scale, occurred in France, in 1866. M. Claude Bernard (Introduction à la médecine expérimentale, Paris, 1866) attacked Bacon's claims as a Reformer of Science, and was answered by M. Paül Janet in the Revue des Deux-Mondes, of April 15, 1866.

Ueber Bacon von Verulam, besonders vom Medicinischen Standpunkte, von Dr. H. von Bamberger. Würzburg, 1865.

De Baconis Baronis de Verulamio Philosophia scripsit Augustus Dorner. Berlin, 1867.

Kirchmann's German Translation, with notes, &c., 1870. (See above, under Translations.)

On the Inductive Philosophy, including a parallel between Lord Bacon and A. Comte, as philosophers. A Lecture, &c., by A. Elley Finch. London, Longmans, 1872.

Flaws in the Philosophy of Bacon, by the Rev. John Doherty, published in the Series of Essays on Religion and Literature edited by Archbishop Manning, 3rd Series, 1874. [This essay follows in the lines of De Maistre, though the tone is more moderate.]

The article on Bacon in the last reprint of the Encyclopaedia Britannica by Mr. Adamson. [This article gives a good deal of interesting matter within a short compass.]

Lord Bacon's 'Philosophy' examined, An Essay read at the Catholic Academy, January, 1877, by the Rev. F. H. Laing, D.D. [The object of this Essay is to shew, in opposition to the 'modern "scientifics,"' that, 'like the Luthers, Zwingles, and Cranmers before him,' Bacon was 'the mere ringleader in a low revolt against the dominion of the cultivated human intellect.']

FRANCISCUS
DE VERULAMIO
SIC COGITAVIT;
TALEMQUE APUD SE
rationem instituit, quam Viventibus et
Posteris notam fieri, ipsorum
interesse putavit.

CUM illi pro comperto esset intellectum humanum sibi ipsi negotium facessere, neque auxiliis veris (quae in hominis potestate sunt) uti sobrie et commode; unde multiplex rerum ignoratio et ex ignoratione rerum detrimenta innumera: omni ope connitendum existimavit, si quo modo commercium istud Mentis et Rerum (cui vix aliquid in terris, aut saltem in terrenis, se ostendit simile) restitui posset in integrum, aut saltem in melius deduci. Ut vero errores qui invaluerunt, quique in aeternum invalituri sunt, alii post alios (si mens sibi permittatur) ipsi se corrigerent, vel ex vi intellectus propria vel ex auxiliis atque adminiculis dialecticae, nulla prorsus suberat spes; propterea quod notiones rerum primae, quas mens haustu facili et supino excipit recondit atque accumulat (unde reliqua omnia fluunt), vitiosae sint et confusae et temere a rebus abstractae; neque minor sit in secundis et reliquis libido et inconstantia; ex quo fit, ut universa ista ratio humana, qua utimur quoad inquisitionem naturae, non bene congesta et aedificata sit, sed tanquam moles aliqua magnifica sine fundamento. Dum enim falsas mentis vires mirantur homines et celebrant, veras ejusdem quae esse possint (si debita ei adhibeantur auxilia, atque ipsa rebus morigera sit, nec impotenter rebus insultet) praetereunt et perdunt. Restabat

illud unum ut res de integro tentetur melioribus praesidiis, utque fiat scientiarum et artium atque omnis humanae doctrinae in universum Instauratio, a debitis excitata fundamentis. Hoc vero licet aggressu infinitum quiddam videri possit ac supra vires mortales, tamen idem tractatu sanum invenietur ac sobrium, magis quam ea quae adhuc facta sunt. Exitus enim hujus rei est nonnullus. In iis vero quae jam fiunt circa scientias, est vertigo quaedam et agitatio perpetua et circulus. Neque eum fugit quanta in solitudine versetur hoc experimentum, et quam durum et incredibile sit ad faciendam fidem. Nihilominus, nec rem nec seipsum deserendum putavit, quin viam quae una humanae menti pervia est tentaret atque iniret. Praestat enim principium dare rei quae exitum habere possit, quam in iis quae exitum nullum habent perpetua contentione et studio implicari. Viae autem contemplativae viis illis activis decantatis fere respondent; ut altera, ab initio ardua et difficilis, desinat in apertum; altera, primo intuitu expedita et proclivis, ducat in avia et praecipitia. Quum autem incertus esset quando haec alicui posthac in mentem ventura sint; eo potissimum usus argumento, quod neminem hactenus invenit qui ad similes cogitationes animum applicuerit; decrevit prima quaeque quae perficere licuit in publicum edere. Neque haec festinatio ambitiosa fuit, sed sollicita; ut si quid illi humanitus accideret, extaret tamen designatio quaedam ac destinatio rei quam animo complexus est; utque extaret simul signum aliquod honestae suae et propensae in generis humani commoda voluntatis. Certe aliam quamcunque ambitionem inferiorem duxit re quam prae manibus habuit. Aut enim hoc quod agitur nihil est, aut tantum, ut merito ipso contentum esse debeat nec fructum extra quaerere.

SERENISSIMO

POTENTISSIMOQUE

PRINCIPI AC DOMINO

NOSTRO,

JACOBO,

DEI GRATIA

MAGNAE BRITANNIAE,

Franciae, et Hiberniae Regi,

FIDEI *Defensori, etc.*

Serenissime Potentissimeque Rex,

POTERIT fortasse Majestas tua me furti incusare, quod tantum temporis quantum ad haec sufficiat negotiis tuis suffuratus sim. Non habeo quod dicam. Temporis enim non fit restitutio; nisi forte quod detractum fuerit temporis rebus tuis, id memoriae nominis tui et honori saeculi tui reponi possit; si modo haec alicujus sint pretii. Sunt certe prorsus nova; etiam toto genere: sed descripta ex veteri admodum exemplari, mundo scilicet ipso, et natura rerum et mentis. Ipse certe (ut ingenue fatear) soleo aestimare hoc opus magis pro partu temporis quam ingenii. Illud enim in eo solummodo mirabile est, initia rei et tantas de iis quae invaluerunt suspiciones alicui in mentem venire potuisse. Caetera non illibenter sequuntur. At versatur proculdubio casus (ut loquimur) et quiddam quasi fortuitum non minus in iis quae cogitant homines quam in iis quae agunt aut loquuntur. Verum hunc casum (de quo loquor) ita intelligi volo, ut si quid in his quae

affero sit boni, id immensae misericordiae et bonitati divinae et foelicitati temporum tuorum tribuatur: cui et vivus integerrimo affectu servivi, et mortuus fortasse id effecero, ut illa posteritati, nova hac accensa face in philosophiae tenebris, praelucere possint. Merito autem temporibus regis omnium sapientissimi et doctissimi Regeneratio ista et Instauratio scientiarum debetur. Superest petitio, Majestate tua non indigna, et maxime omnium faciens ad id quod agitur. Ea est, ut quando Salomonem in plurimis referas, judiciorum gravitate, regno pacifico, cordis latitudine, librorum denique quos composuisti nobili varietate, etiam hoc ad ejusdem regis exemplum addas, ut cures Historiam Naturalem et Experimentalem, veram et severam (missis philologicis), et quae sit in ordine ad condendam philosophiam, denique qualem suo loco describemus, congeri et perfici: ut tandem post tot mundi aetates philosophia et scientiae non sint amplius pensiles et aëreae, sed solidis experientiae omnigenae, ejusdemque bene pensitatae, nitantur fundamentis. Equidem Organum praebui; verum materies a rebus ipsis petenda est. Deus Opt. Max. Majestatem tuam diu servet incolumem.

Serenissimae Majestati tuae

Servus devinctissimus,

et

devotissimus,

FRANCISCUS VERULAM,

CANCELLARIUS.

FRANCISCI
DE VERULAMIO
INSTAURATIO
MAGNA.

Praefatio.

De statu scientiarum, quod non sit foelix aut majorem in modum auctus; quodque alia omnino quam prioribus cognita fuerit via aperienda sit intellectui humano, et alia comparanda auxilia, ut mens suo jure in rerum naturam uti possit.

VIDENTUR nobis homines nec opes nec vires suas bene nosse; verum de illis majora quam par est, de his minora credere. Ita fit, ut aut artes receptas insanis pretiis aestimantes nil amplius quaerant, aut seipsos plus aequo contemnentes vires suas in levioribus consumant, in iis quae ad summam rei faciant non experiantur. Quare sunt et suae scientiis columnae tanquam fatales; cum ad ulterius penetrandum homines nec desiderio nec spe excitentur. Atque cum opinio copiae inter maximas causas inopiae sit; quumque ex fiducia praesentium vera auxilia negligantur in posterum; ex usu est, et plane ex necessitate, ut ab illis quae adhuc inventa sunt in ipso operis nostri limine (idque relictis ambagibus et non dissimulanter) honoris et admirationis excessus tollatur; utili monito, ne homines eorum aut copiam aut utilitatem in majus accipiant aut celebrent. Nam si quis in

omnem illam librorum varietatem qua artes et scientiae exultant diligentius introspiciat, ubique inveniet ejusdem rei repetitiones infinitas, tractandi modis diversas, inventione praeoccupatas; ut omnia primo intuitu numerosa, facto examine pauca reperiantur. Et de utilitate aperte dicendum est, sapientiam istam quam a Graecis potissimum hausimus pueritiam quandam scientiae videri, atque habere quod proprium est puerorum, ut ad garriendum prompta, ad generandum invalida et immatura sit. Controversiarum enim ferax, operum effoeta est. Adeo ut fabula illa de Scylla in literarum statum, qualis habetur, ad vivum quadrare videatur; quae virginis os et vultum extulit, ad uterum vero monstra latrantia succingebantur et adhaerebant. Ita habent et scientiae quibus insuevimus generalia quaedam blandientia et speciosa, sed cum ad particularia ventum sit, veluti ad partes generationis, ut fructum et opera ex se edant, tum contentiones et oblatrantes disputationes exoriuntur, in quas desinunt, et quae partus locum obtinent. Praeterea, si hujusmodi scientiae plane res mortua non essent, id minime videtur eventurum fuisse quod per multa jam saecula usu venit, ut illae suis immotae fere haereant vestigiis, nec incrementa genere humano digna sumant: eo usque, ut saepenumero non solum assertio maneat assertio sed etiam quaestio maneat quaestio, et per disputationes non solvatur sed figatur et alatur, omnisque traditio et successio disciplinarum repraesentet et exhibeat personas magistri et auditoris, non inventoris et ejus qui inventis aliquid eximium adjiciat. In artibus autem mechanicis contrarium evenire videmus; quae, ac si aurae cujusdam vitalis forent participes, quotidie crescunt et perficiuntur, et in primis authoribus rudes plerunque et fere onerosae et informes apparent, postea vero novas virtutes et commoditatem quandam adipiscuntur, eo usque, ut citius studia hominum et cupiditates deficiant et mutentur, quam illae ad culmen et perfectionem suam pervenerint. Philosophia contra et scientiae intellectuales, statuarum more, adorantur et celebrantur, sed non promoventur. Quin etiam in primo nonnunquam authore maxime vigent, et deinceps degenerant. Nam postquam homines dedititii facti sint et in unius sententiam (tanquam pedarii senatores) coierint, scientiis ipsis amplitudinem non addunt, sed in certis

authoribus ornandis et stipandis servili officio funguntur. Neque illud afferat quispiam, scientias paullatim succrescentes tandem ad statum quendam pervenisse, et tum demum (quasi confectis spatiis legitimis) in operibus paucorum sedes fixas posuisse; atque postquam nil melius inveniri potuerit, restare scilicet ut quae inventa sint exornentur et colantur. Atque optandum quidem esset haec ita se habuisse. Rectius illud et verius, istas scientiarum mancipationes nil aliud esse quam rem ex paucorum hominum confidentia et reliquorum socordia et inertia natam. Postquam enim scientiae per partes diligenter fortasse excultae et tractatae fuerint, tum forte exortus est aliquis, ingenio audax et propter methodi compendia acceptus et celebratus, qui specie tenus artem constituerit, revera veterum labores corruperit. Id tamen posteris gratum esse solet, propter usum operis expeditum et inquisitionis novae taedium et impatientiam. Quod si quis consensu jam inveterato tanquam temporis judicio moveatur, sciat se ratione admodum fallaci et infirma niti. Neque enim nobis magna ex parte notum est, quid in scientiis et artibus, variis saeculis et locis, innotuerit et in publicum emanarit; multo minus, quid a singulis tentatum sit et secreto agitatum. Itaque nec temporis partus nec abortus extant in fastis. Neque ipse consensus ejusque diuturnitas magni prorsus aestimandus est. Utcunque enim varia sint genera politiarum, unicus est status scientiarum, isque semper fuit et mansurus est popularis. Atque apud populum plurimum vigent doctrinae aut contentiosae et pugnaces aut speciosae et inanes, quales videlicet assensum aut illaqueant aut demulcent. Itaque maxima ingenia proculdubio per singulas aetates vim passa sunt; dum viri captu et intellectu non vulgares, nihilo secius existimationi suae consulentes, temporis et multitudinis judicio se submiserint. Quamobrem altiores contemplationes si forte usquam emicuerint, opinionum vulgarium ventis subinde agitatae sunt et extinctae. Adeo ut Tempus, tanquam fluvius, levia et inflata ad nos devexerit, gravia et solida demerserit. Quin et illi ipsi authores qui dictaturam quandam in scientiis invaserunt et tanta confidentia de rebus pronuntiant, cum tamen per intervalla ad se redeunt, ad querimonias de subtilitate naturae, veritatis recessibus, rerum obscuritate, causarum

implicatione, ingenii humani infirmitate, se convertunt; in hoc nihilo tamen modestiores, cum malint communem hominum et rerum conditionem causari quam de seipsis confiteri. Quin illis hoc fere solenne est, ut quicquid ars aliqua non attingat id ipsum ex eadem arte impossibile esse statuant. Neque vero damnari potest ars, quum ipsa disceptet et judicet. Itaque id agitur, ut ignorantia etiam ab ignominia liberetur. Atque quae tradita et recepta sunt ad hunc fere modum se habent: quoad opera sterilia, quaestionum plena; incrementis suis tarda et languida; perfectionem in toto simulantia, sed per partes male impleta; delectu autem popularia et authoribus ipsis suspecta, ideoque artificiis quibusdam munita et ostentata. Qui autem et ipsi experiri et se scientiis addere earumque fines proferre statuerunt, nec illi a receptis prorsus desciscere ausi sunt, nec fontes rerum petere. Verum se magnum quiddam consequutos putant si aliquid ex proprio inserant et adjiciant; prudenter secum reputantes, se in assentiendo modestiam, in adjiciendo libertatem tueri posse. Verum dum opinionibus et moribus consulitur, mediocritates istae laudatae in magnum scientiarum detrimentum cedunt. Vix enim datur authores simul et admirari et superare. Sed fit aquarum more, quae non altius ascendunt quam ex quo descenderunt. Itaque hujusmodi homines emendant nonnulla sed parum promovent, et proficiunt in melius non in majus. Neque tamen defuerunt, qui ausu majore omnia integra sibi duxerunt, et ingenii impetu usi, priora prosternendo et destruendo aditum sibi et placitis suis fecerunt; quorum tumultu non magnopere profectum est: quum philosophiam et artes non re ac opere amplificare, sed placita tantum permutare atque regnum opinionum in se transferre contenderint; exiguo sane fructu, quum inter errores oppositos errandi causae sint fere communes. Si qui autem nec alienis nec propriis placitis obnoxii, sed libertati faventes, ita animati fuere ut alios secum simul quaerere cuperent; illi sane affectu honesti, sed conatu invalidi fuerunt. Probabiles enim tantum rationes secuti videntur, et argumentorum vertigine circumaguntur, et promiscua quaerendi licentia severitatem inquisitionis enervarunt. Nemo autem reperitur, qui in rebus ipsis et experientia moram fecerit legitimam. Atque nonnulli rursus qui experientiae undis se commisere et fere

mechanici facti sunt, tamen in ipsa experientia erraticam quandam inquisitionem exercent, nec ei certa lege militant. Quin et plerique pusilla quaedam pensa sibi proposuere, pro magno ducentes si unum aliquod inventum eruere possint; instituto non minus tenui, quam imperito. Nemo enim rei alicujus naturam in ipsa re recte aut foeliciter perscrutatur; verum post laboriosam experimentorum variationem non acquiescit, sed invenit quod ulterius quaerat. Neque illud imprimis omittendum est, quod omnis in experiendo industria statim ab initio opera quaedam destinata praepropero et intempestivo studio captavit; fructifera (inquam) experimenta, non lucifera, quaesivit; nec ordinem divinum imitata est, qui primo die lucem tantum creavit, eique unum diem integrum attribuit; neque illo die quicquam materiati operis produxit, verum sequentibus diebus ad ea descendit. At qui summas dialecticae partes tribuerunt atque inde fidissima scientiis praesidia comparari putarunt, verissime et optime viderunt intellectum humanum sibi permissum merito suspectum esse debere. Verum infirmior omnino est malo medicina; nec ipsa mali expers. Siquidem dialectica quae recepta est, licet ad civilia et artes quae in sermone et opinione positae sunt rectissime adhibeatur, naturae tamen subtilitatem longo intervallo non attingit; et prensando quod non capit, ad errores potius stabiliendos et quasi figendos quam ad viam veritati aperiendam valuit.

Quare, ut quae dicta sunt complectamur, non videtur hominibus aut aliena fides aut industria propria circa scientias hactenus foeliciter illuxisse; praesertim quum et in demonstrationibus et in experimentis adhuc cognitis parum sit praesidii. Aedificium autem hujus universi, structura sua, intellectui humano contemplanti, instar labyrinthi est; ubi tot ambigua viarum, tam fallaces rerum et signorum similitudines, tam obliquae et implexae naturarum spirae et nodi, undequaque se ostendunt. Iter autem sub incerto sensus lumine, interdum affulgente, interdum se condente, per experientiae et rerum particularium sylvas perpetuo faciendum est. Quin etiam duces itineris (ut dictum est) qui se offerunt, et ipsi implicantur, atque errorum et errantium numerum augent. In rebus tam duris, de judicio hominum ex vi propria, aut etiam de

foelicitate fortuita, desperandum est. Neque enim ingeniorum quantacunque excellentia, neque experiendi alea saepius repetita, ista vincere queat. Vestigia filo regenda sunt: omnisque via, usque a primis ipsis sensuum perceptionibus, certa ratione munienda. Neque haec ita accipienda sunt, ac si nihil omnino tot saeculis, tantis laboribus, actum sit. Neque enim eorum quae inventa sunt nos poenitet. Atque antiqui certe, in iis quae in ingenio et meditatione abstracta posita sunt, mirabiles se viros praestitere. Verum quemadmodum saeculis prioribus, cum homines in navigando per stellarum tantum observationes cursum dirigebant, veteris sane continentis oras legere potuerunt, aut maria aliqua minora et mediterranea trajicere; priusquam autem oceanus trajiceretur et novi orbis regiones detegerentur, necesse fuit usum acus nauticae, ut ducem viae magis fidum et certum, innotuisse: simili prorsus ratione, quae hucusque in artibus et scientiis inventa sunt, ea hujusmodi sunt ut usu, meditatione, observando, argumentando, reperiri potuerint; utpote quae sensibus propiora sint et communibus notionibus fere subjaceant; antequam vero ad remotiora et occultiora naturae liceat appellere, necessario requiritur ut melior et perfectior mentis et intellectus humani usus et adoperatio introducatur.

Nos certe, aeterno veritatis amore devicti, viarum incertis et arduis et solitudinibus nos commisimus; et divino auxilio freti et innixi, mentem nostram et contra opinionum violentias et quasi instructas acies, et contra proprias et internas haesitationes et scrupulos, et contra rerum caligines et nubes et undequaque volantes phantasias, sustinuimus; ut tandem magis fida et secura indicia viventibus et posteris comparare possemus. Qua in re si quid profecerimus, non alia sane ratio nobis viam aperuit quam vera et legitima spiritus humani humiliatio. Omnes enim ante nos, qui ad artes inveniendas se applicuerunt, conjectis paulisper in res et exempla et experientiam oculis, statim, quasi inventio nil aliud esset quam quaedam excogitatio, spiritus proprios ut sibi oracula exhiberent quodammodo invocarunt. Nos vero inter res caste et perpetuo versantes, intellectum longius a rebus non abstrahimus quam ut rerum imagines et radii (ut in sensu fit) coire possint; unde fit, ut ingenii viribus et excellentiae non multum relinquatur. Atque

quam in inveniendo adhibemus humilitatem, eandem et in docendo sequuti sumus. Neque enim aut confutationum triumphis, aut antiquitatis advocationibus, aut authoritatis usurpatione quadam, aut etiam obscuritatis velo, aliquam his nostris inventis majestatem imponere aut conciliare conamur; qualia reperire non difficile esset ei, qui nomini suo non animis aliorum lumen affundere conaretur. Non (inquam) ullam aut vim aut insidias hominum judiciis fecimus aut paramus; verum eos ad res ipsas et rerum foedera adducimus; ut ipsi videant quid habeant, quid arguant, quid addant atque in commune conferant. Nos autem si qua in re vel male credidimus, vel obdormivimus et minus attendimus, vel defecimus in via et inquisitionem abrupimus, nihilominus iis modis res nudas et apertas exhibemus, ut errores nostri, antequam scientiae massam altius inficiant, notari et separari possint; atque etiam ut facilis et expedita sit laborum nostrorum continuatio. Atque hoc modo inter empiricam et rationalem facultatem (quarum morosa et inauspicata divortia et repudia omnia in humana familia turbavere) conjugium verum et legitimum in perpetuum nos firmasse existimamus.

Quamobrem, quum haec arbitrii nostri non sint, in principio operis, ad Deum Patrem, Deum Verbum, Deum Spiritum, preces fundimus humillimas et ardentissimas, ut humani generis aerumnarum memores et peregrinationis istius vitae in qua dies paucos et malos terimus, novis suis eleemosynis, per manus nostras, familiam humanam dotare dignentur. Atque illud insuper supplices rogamus, ne humana divinis officiant, neve ex reseratione viarum sensus et accensione majore luminis naturalis aliquid incredulitatis et noctis animis nostris erga divina mysteria oboriatur: sed potius, ut ab intellectu puro, a phantasiis et vanitate repurgato et divinis oraculis nihilominus subdito et prorsus dedititio, fidei dentur quae fidei sunt. Postremo, ut scientiae veneno a serpente infuso, quo animus humanus tumet et inflatur, deposito, nec altum sapiamus nec ultra sobrium, sed veritatem in charitate colamus.

Peractis autem votis, ad homines conversi, quaedam et salutaria monemus et aequa postulamus. Monemus primum (quod etiam precati sumus) ut homines sensum in officio,

quoad divina, contineant. Sensus enim (instar solis) globi terrestris faciem aperit, coelestis claudit et obsignat. Rursus, ne hujusce mali fuga in contrarium peccent; quod certe fiet, si naturae inquisitionem ulla ex parte veluti interdicto separatam putant. Neque enim pura illa et immaculata scientia naturalis, per quam Adam nomina ex proprietate rebus imposuit, principium aut occasionem lapsui dedit. Sed ambitiosa illa et imperativa scientiae moralis, de bono et malo dijudicantis, cupiditas, ad hoc ut Homo a Deo deficeret et sibi ipsi leges daret, ea demum ratio atque modus tentationis fuit. De scientiis autem quae naturam contemplantur sanctus ille philosophus pronuntiat, *Gloriam Dei esse celare rem; gloriam regis autem rem invenire:* non aliter ac si divina natura innocenti et benevolo puerorum ludo delectaretur, qui ideo se abscondunt ut inveniantur; atque animam humanam sibi collusorem in hoc ludo pro sua in homines indulgentia et bonitate cooptaverit. Postremo omnes in universum monitos volumus, ut scientiae veros fines cogitent; nec eam aut animi causa petant, aut ad contentionem, aut ut alios despiciant, aut ad commodum, aut ad famam, aut ad potentiam, aut hujusmodi inferiora; sed ad meritum et usus vitae; eamque in charitate perficiant et regant. Ex appetitu enim potentiae angeli lapsi sunt; ex appetitu scientiae, homines; sed charitatis non est excessus; neque angelus aut homo per eam unquam in periculum venit.

Postulata autem nostra quae afferimus talia sunt. De nobis ipsis silemus: de re autem quae agitur petimus, ut homines eam non opinionem sed opus esse cogitent; ac pro certo habeant, non sectae nos alicujus aut placiti, sed utilitatis et amplitudinis humanae fundamenta moliri. Deinde ut suis commodis aequi, exutis opinionum zelis et praejudiciis, in commune consulant; ac ab erroribus viarum atque impedimentis, nostris praesidiis et auxiliis, liberati et muniti, laborum qui restant et ipsi in partem veniant. Praeterea, ut bene sperent; neque *Instaurationem* nostram, ut quiddam infinitum et ultra mortale, fingant et animo concipiant; quum revera sit infiniti erroris finis et terminus legitimus; mortalitatis autem et humanitatis non sit immemor; quum rem non intra unius aetatis curriculum omnino perfici

posse confidat, sed successioni destinet; denique scientias, non per arrogantiam in humani ingenii cellulis, sed submisse in mundo majore quaerat. Vasta vero ut plurimum solent esse, quae inania: solida contrahuntur maxime, et in parvo sita sunt. Postremo etiam petendum videtur (ne forte quis rei ipsius periculo nobis iniquus esse velit) ut videant homines, quatenus ex eo quod nobis asserere necesse sit (si modo nobis ipsi constare velimus) de his nostris opinandi aut sententiam ferendi sibi jus permissum putent: quum nos omnem istam rationem humanam praematuram, anticipantem, et a rebus temere et citius quam oportuit abstractam, (quatenus ad inquisitionem naturae) ut rem variam et perturbatam et male extructam rejiciamus. Neque postulandum est ut ejus judicio stetur, quae ipsa in judicium vocatur.

DISTRIBUTIO
OPERIS.

Ejus constituuntur Partes sex.

Prima; *Partitiones Scientiarum.*
Secunda; *Novum Organum*, sive *Indicia de Interpretatione Naturae.*
Tertia; *Phaenomena Universi*, sive *Historia Naturalis et Experimentalis ad condendam Philosophiam.*
Quarta; *Scala Intellectus.*
Quinta; *Prodromi*, sive *Anticipationes Philosophiae Secundae.*
Sexta; *Philosophia Secunda*, sive *Scientia Activa.*

Singularum Argumenta.

PARS autem instituti nostri est, ut omnia, quantum fieri potest aperte et perspicue proponantur. Nuditas enim animi, ut olim corporis, innocentiae et simplicitatis comes est. Pateat itaque primo ordo operis atque ratio ejus. Partes operis a nobis constituuntur sex.

Prima pars exhibet scientiae ejus sive doctrinae in cujus possessione humanum genus hactenus versatur, Summam, sive descriptionem universalem. Visum enim est nobis etiam in iis quae recepta sunt nonnullam facere moram: eo nimirum consilio, ut facilius et veteribus perfectio et novis aditus detur. Pari enim fere studio ferimur et ad vetera excolenda et ad ulteriora assequenda. Pertinet etiam hoc ad faciendam fidem: juxta illud, *Non accipit indoctus verba scientiae, nisi prius ea dixeris quae versantur in corde ejus.* Itaque scientiarum atque artium receptarum oras legere, necnon utilia quaedam in illas importare, tanquam in transitu, non negligemus.

Partitiones tamen Scientiarum adhibemus eas, quae non tantum jam inventa et nota, sed hactenus omissa et debita, complectantur. Etenim inveniuntur in globo intellectuali, quemadmodum in terrestri, et culta pariter et deserta. Itaque nil mirum videri debet, si a divisionibus usitatis quandoque recedamus. Adjectio enim, dum totum variat, etiam partes earumque sectiones necessario variat: receptae autem divisiones receptae summae scientiarum, qualis nunc est, tantum competunt.

Circa ea vero quae ceu omissa notabimus, ita nos geremus, ut non leves tantum titulos et argumenta concisa eorum quae desiderantur proponamus. Nam siquid inter omissa retulerimus (modo sit dignioris subjecti) cujus ratio paulo videatur obscurior, adeo ut merito suspicari possimus homines non facile intellecturos quid nobis velimus aut quale sit illud opus quod animo et cogitatione complectimur, perpetuo nobis curae erit aut praecepta hujusmodi operis conficiendi aut etiam partem operis ipsius jam a nobis confectam ad exemplum totius subjungere; ut in singulis aut opera aut consilio juvemus. Etenim etiam ad nostram existimationem, non solum aliorum utilitatem, pertinere putavimus, ne quis arbitretur levem aliquam de istiusmodi rebus notionem mentem nostram perstrinxisse, atque esse illa quae desideramus ac prensamus tanquam votis similia. Ea vero talia sunt, quorum et penes homines (nisi sibi ipsi desint) potestas plane sit, et nos apud nosmet rationem quandam certam et explicatam habeamus. Neque enim regiones metiri animo, ut augures, auspiciorum causa: sed intrare, ut duces, promerendi studio, suscepimus.

Atque haec prima operis pars est.

Porro praetervecti artes veteres, intellectum humanum ad trajiciendum instruemus. Destinatur itaque parti secundae, doctrina de meliore et perfectiore usu rationis in rerum inquisitione, et de auxiliis veris intellectus: ut per hoc (quantum conditio humanitatis ac mortalitatis patitur) exaltetur intellectus, et facultate amplificetur ad naturae ardua et obscura superanda. Atque est ea quam adducimus ars (quam *Interpretationem Naturae* appellare consuevimus) ex genere logicae; licet plurimum, atque adeo immensum quiddam,

intersit. Nam et ipsa illa logica vulgaris auxilia et praesidia intellectui moliri ac parare profitetur: et in hoc uno consentiunt. Differt autem plane a vulgari rebus praecipue tribus: viz. ipso fine, ordine demonstrandi, et inquirendi initiis.

Nam huic nostrae scientiae finis proponitur, ut inveniantur non argumenta sed artes, nec principiis consentanea sed ipsa principia, nec rationes probabiles sed designationes et indicationes Operum. Itaque ex intentione diversa diversus sequitur effectus. Illic enim adversarius disputatione vincitur et constringitur; hic natura, opere.

Atque cum hujusmodi fine conveniunt demonstrationum ipsarum natura et ordo. In logica enim vulgari opera fere universa circa Syllogismum consumitur. De Inductione vero Dialectici vix serio cogitasse videntur; levi mentione eam transmittentes, et ad disputandi formulas properantes. At nos demonstrationem per syllogismum rejicimus, quod confusius agat, et naturam emittat e manibus. Tametsi enim nemini dubium esse possit quin, quae in medio termino conveniunt, ea et inter se conveniant (quod est mathematicae cujusdam certitudinis): nihilominus hoc subest fraudis, quod syllogismus ex propositionibus constet, propositiones ex verbis, verba autem notionum tesserae et signa sint. Itaque si notiones ipsae mentis (quae verborum quasi anima sunt, et totius hujusmodi structurae ac fabricae basis) male ac temere a rebus abstractae, et vagae, nec satis definitae et circumscriptae, denique multis modis vitiosae fuerint, omnia ruunt. Rejicimus igitur syllogismum; neque id solum quoad principia (ad quae nec illi eam adhibent) sed etiam quoad propositiones medias, quas educit sane atque parturit utcunque syllogismus, sed operum steriles et a practica remotas et plane quoad partem activam scientiarum incompetentes. Quamvis igitur relinquamus syllogismo et hujusmodi demonstrationibus famosis ac jactatis jurisdictionem in artes populares et opinabiles (nil enim in hac parte movemus), tamen ad naturam rerum Inductione per omnia, et tam ad minores propositiones quam ad majores, utimur. *Inductionem* enim censemus eam esse demonstrandi formam, quae sensum tuetur et naturam premit et operibus imminet ac fere immiscetur.

Itaque ordo quoque demonstrandi plane invertitur. Adhuc

enim res ita geri consuevit; ut a sensu et particularibus primo loco ad maxime generalia advoletur, tanquam ad polos fixos circa quos disputationes vertantur; ab illis caetera per media deriventur: via certe compendiaria, sed praecipiti, et ad naturam impervia, ad disputationes vero proclivi et accommodata. At secundum nos, axiomata continenter et gradatim excitantur, ut nonnisi postremo loco ad generalissima veniatur: ea vero generalissima evadunt non notionalia, sed bene terminata, et talia quae natura ut revera sibi notiora agnoscat, quaeque rebus haereant in medullis.

At in forma ipsa quoque inductionis, et judicio quod per eam fit, opus longe maximum movemus. Ea enim de qua dialectici loquuntur, quae procedit per enumerationem simplicem, puerile quiddam est, et precario concludit, et periculo ab instantia contradictoria exponitur, et consueta tantum intuetur, nec exitum reperit.

Atqui opus est ad scientias inductionis forma tali, quae experientiam solvat et separet, et per exclusiones ac rejectiones debitas necessario concludat. Quod si judicium illud vulgatum dialecticorum tam operosum fuerit, et tanta ingenia exercuerit; quanto magis laborandum est in hoc altero, quod non tantum ex mentis penetralibus, sed etiam ex naturae visceribus extrahitur?

Neque tamen hic finis. Nam fundamenta quoque scientiarum fortius deprimimus et solidamus, atque initia inquirendi altius sumimus, quam adhuc homines fecerunt: ea subjiciendo examini, quae logica vulgaris tanquam fide aliena recipit. Etenim dialectici principia scientiarum a scientiis singulis tanquam mutuo sumunt: rursus, notiones mentis primas venerantur: postremo, informationibus immediatis sensus bene dispositi acquiescunt. At nos logicam veram singulas scientiarum provincias majore cum imperio quam penes ipsarum principia sit debere ingredi decrevimus, atque illa ipsa principia putativa ad rationes reddendas compellere quousque plane constent. Quod vero attinet ad notiones primas intellectus; nihil est eorum quae intellectus sibi permissus congessit, quin nobis pro suspecto sit, nec ullo modo ratum, nisi novo judicio se stiterit et secundum illud pronuntiatum fuerit. Quinetiam sensus ipsius informationes multis modis excutimus.

Sensus enim fallunt utique, sed et errores suos indicant: verum errores praesto, indicia eorum longe petita sunt.

Duplex autem est sensus culpa: aut enim destituit nos aut decipit. Nam primo, plurimae sunt res quae sensum etiam recte dispositum nec ullo modo impeditum effugiunt; aut subtilitate totius corporis, aut partium minutiis, aut loci distantia, aut tarditate atque etiam velocitate motus, aut familiaritate objecti, aut alias ob causas. Neque rursus, ubi sensus rem tenet, prehensiones ejus admodum firmae sunt. Nam testimonium et informatio sensus semper est ex analogia hominis, non ex analogia universi: atque magno prorsus errore asseritur, sensum esse mensuram rerum.

Itaque ut his occurratur, nos multo et fido ministerio auxilia sensui undique conquisivimus et contraximus, ut destitutionibus substitutiones, variationibus rectificationes suppeditentur. Neque id molimur tam instrumentis quam experimentis. Etenim experimentorum longe major est subtilitas quam sensus ipsius, licet instrumentis exquisitis adjuti; (de iis loquimur experimentis, quae ad intentionem ejus quod quaeritur perite et secundum artem excogitata et apposita sunt). Itaque perceptioni sensus immediatae ac propriae non multum tribuimus: sed eo rem deducimus, ut sensus tantum de experimento, experimentum de re judicet. Quare existimamus nos sensus (a quo omnia in naturalibus petenda sunt, nisi forte libeat insanire) antistites religiosos, et oraculorum ejus non imperitos interpretes, nos praestitisse: ut alii professione quadam, nos re ipsa, sensum tueri ac colere videamur. Atque hujusmodi sunt ea quae ad lumen ipsum naturae ejusque accensionem et immissionem paramus: quae per se sufficere possent, si intellectus humanus aequus et instar tabulae abrasae esset. Sed cum mentes hominum miris modis adeo obsessae sint ut ad veros rerum radios excipiendos sincera et polita area prorsus desit, necessitas quaedam incumbit ut etiam huic rei remedium quaerendum esse putemus.

Idola autem a quibus occupatur mens, vel Adscititia sunt vel Innata. Adscititia vero immigrarunt in mentes hominum, vel ex philosophorum placitis et sectis vel ex perversis legibus demonstrationum. At Innata inhaerent naturae ipsius intellectus, qui ad errorem longe proclivior esse deprehenditur

quam sensus. Utcunque enim homines sibi placeant et in admirationem mentis humanae ac fere adorationem ruant, illud certissimum est: sicut speculum inaequale rerum radios ex figura et sectione propria immutat, ita et mentem, cum a rebus per sensum patitur, in notionibus suis expediendis et comminiscendis haud optima fide rerum naturae suam naturam inserere et immiscere.

Atque priora illa duo *Idolorum* genera aegre, postrema vero haec nullo modo, evelli possunt. Id tantum relinquitur, ut indicentur, atque ut vis ista mentis insidiatrix notetur et convincatur; ne forte a destructione veterum novi subinde errorum surculi ex ipsa mala complexione mentis pullulent, eoque res recidat, ut errores non extinguantur sed permutentur; verum e contra ut illud tandem in aeternum ratum et fixum sit, intellectum nisi per inductionem ejusque formam legitimam judicare non posse. Itaque doctrina ista de expurgatione intellectus ut ipse ad veritatem habilis sit, tribus redargutionibus absolvitur: redargutione philosophiarum, redargutione demonstrationum, et redargutione rationis humanae nativae. His vero explicatis, ac postquam demum patuerit quid rerum natura, quid mentis natura ferat, existimamus nos thalamum Mentis et Universi, pronuba divina bonitate, stravisse et ornasse. Epithalamii autem votum sit, ut ex eo connubio auxilia humana et stirps inventorum quae necessitates ac miserias hominum aliqua ex parte doment et subigant, suscipiatur. *Haec vero est operis pars secunda.*

At vias non solum monstrare et munire, sed inire quoque consilium est. Itaque tertia pars operis complectitur *Phaenomena Universi;* hoc est, omnigenam experientiam, atque historiam naturalem ejus generis quae possit esse ad condendam philosophiam fundamentalis. Neque enim excellens aliqua demonstrandi via sive naturam interpretandi forma, ut mentem ab errore et lapsu defendere ac sustinere, ita ei materiam ad sciendum praebere et subministrare possit. Verum iis quibus non conjicere et hariolari, sed invenire et scire propositum est, quique non simiolas et fabulas mundorum comminisci, sed hujus ipsius veri mundi naturam introspicere et velut dissecare in animo habent, omnia a rebus ipsis petenda

sunt. Neque huic labori et inquisitioni ac mundanae perambulationi, ulla ingenii aut meditationis aut argumentationis substitutio aut compensatio sufficere potest; non si omnia omnium ingenia coierint. Itaque aut hoc prorsus habendum, aut negotium in perpetuum deserendum. Ad hunc vero usque diem ita cum hominibus actum est, ut minime mirum sit si natura sui copiam non faciat.

Nam primo, sensus ipsius informatio, et deserens et fallens; observatio, indiligens et inaequalis et tanquam fortuita; traditio, vana et ex rumore; practica, operi intenta et servilis; vis experimentalis, caeca, stupida, vaga, et praerupta; denique historia naturalis, levis et inops, vitiosissimam materiam intellectui ad philosophiam et scientias congesserunt.

Deinde, praepostera argumentandi subtilitas et ventilatio serum rebus plane desperatis tentatur remedium, nec negotium ullo modo restituit aut errores separat. Itaque nulla spes majoris augmenti ac progressus sita est, nisi in restauratione quadam scientiarum.

Hujus autem exordia omnino a naturali historia sumenda sunt, eaque ipsa novi cujusdam generis et apparatus. Frustra enim fuerit speculum expolire, si desint imagines; et plane materia idonea praeparanda est intellectui, non solum praesidia fida comparanda. Differt vero rursus historia nostra (quemadmodum logica nostra) ab ea quae habetur, multis rebus: fine sive officio, ipsa mole et congerie, dein subtilitate, etiam delectu et constitutione in ordine ad ea quae sequuntur.

Primo enim eam proponimus historiam naturalem, quae non tam aut rerum varietate delectet aut praesenti experimentorum fructu juvet, quam lucem inventioni causarum affundat, et philosophiae enutricandae primam mammam praebeat. Licet enim opera atque activam scientiarum partem praecipue sequamur, tamen messis tempus expectamus, nec muscum et segetem herbidam demetere conamur. Satis enim scimus, axiomata recte inventa tota agmina operum secum trahere, atque opera non sparsim sed confertim exhibere. Intempestivum autem illum et puerilem affectum, ut pignora aliqua novorum operum propere captentur, prorsus damnamus et amovemus, ceu pomum Atalantae quod cursum retardat. Atque Historiae nostrae Naturalis officium tale est.

Quoad congeriem vero, conficimus historiam non solum naturae liberae ac solutae (cum scilicet illa sponte fluit et opus suum peragit), qualis est historia coelestium, meteororum, terrae et maris, mineralium, plantarum, animalium; sed multo magis naturae constrictae et vexatae; nempe, cum per artem et ministerium humanum de statu suo detruditur, atque premitur et fingitur. Itaque omnia artium mechanicarum, omnia operativae partis liberalium, omnia practicarum complurium quae in artem propriam non coaluerunt, experimenta (quantum inquirere licuit et quantum ad finem nostrum faciunt) perscribimus. Quin etiam (ut quod res est eloquamur) fastum hominum et speciosa nil morati, multo plus et operae et praesidii in hac parte quam in illa altera ponimus; quandoquidem natura rerum magis se prodit per vexationes artis quam in libertate propria.

Neque Corporum tantum historiam exhibemus; sed diligentiae insuper nostrae esse putavimus, etiam Virtutum ipsarum (illarum dicimus quae tanquam cardinales in natura censeri possint, et in quibus naturae primordia plane constituuntur, utpote materiae primis passionibus ac desideriis, viz. *Denso*, *Raro*, *Calido*, *Frigido*, *Consistenti*, *Fluido*, *Gravi*, *Levi*, aliisque haud paucis) historiam seorsum comparare.

Enimvero ut de subtilitate dicamus, plane conquirimus genus experimentorum longe subtilius et simplicius quam sunt ea quae occurrunt. Complura enim a tenebris educimus et eruimus, quae nulli in mentem venisset investigare, nisi qui certo et constanti tramite ad inventionem causarum pergeret; cum in se nullius magnopere sint usus; ut liquido appareat, ea non propter se quaesita esse; sed ita prorsus se habeant illa ad res et opera quemadmodum literae alphabeti se habeant ad orationem et verba; quae licet per se inutiles eaedem tamen omnis sermonis elementa sunt.

In delectu autem narrationum et experimentorum melius hominibus cavisse nos arbitramur, quam qui adhuc in historia naturali versati sunt. Nam omnia fide oculata aut saltem perspecta, et summa quadam cum severitate, recipimus; ita ut nil referatur auctum miraculi causa, sed quae narramus a fabulis et vanitate casta et intemerata sint. Quinetiam et recepta quaeque ac jactata mendacia (quae mirabili quodam

neglectu per saecula multa obtinuerunt et inveterata sunt) nominatim proscribimus et notamus; ne scientiis amplius molesta sint. Quod enim prudenter animadvertit quidam, fabulas et superstitiones et nugas quas nutriculae pueris instillant, mentes eorum etiam serio depravare: ita eadem nos movit ratio ut solliciti atque etiam anxii simus ne ab initio, cum veluti infantiam philosophiae sub historia naturali tractemus et curemus, illa alicui vanitati assuescat. At in omni experimento novo et paulo subtiliore, licet (ut nobis videtur) certo ac probato, modum tamen experimenti quo usi sumus aperte subjungimus; ut, postquam patefactum sit quomodo singula nobis constiterint, videant homines quid erroris subesse et adhaerere possit, atque ad probationes magis fidas et magis exquisitas (si quae sint) expergiscantur: denique ubique monita et scrupulos et cautiones aspergimus, religione quadam et tanquam exorcismo omnia phantasmata ejicientes ac cohibentes.

Postremo, cum nobis exploratum sit quantopere experientia et historia aciem mentis humanae disgreget, et quam difficile sit (praesertim animis vel teneris vel praeoccupatis) a principio cum natura consuescere, adjungimus saepius observationes nostras, tanquam primas quasdam conversiones et inclinationes ac veluti aspectus historiae ad philosophiam; ut et pignoris loco hominibus sint eos in historiae fluctibus perpetuo non detentos iri, utque cum ad opus intellectus deveniatur omnia sint magis in procinctu. Atque per hujusmodi (qualem describimus) Historiam Naturalem, aditum quendam fieri posse ad naturam tutum et commodum, atque materiam intellectui praeberi probam et praeparatam, censemus.

Postquam vero et intellectum fidissimis auxiliis se praesidiis stipavimus, et justum divinorum operum exercitum severissimo delectu comparavimus; nil amplius superesse videtur, nisi ut philosophiam ipsam aggrediamur. Attamen in re tam ardua et suspensa, sunt quaedam quae necessario videntur interponenda; partim docendi gratia, partim in usum praesentem.

Horum primum est, ut exempla proponantur inquirendi et inveniendi secundum nostram rationem ac viam, in aliquibus subjectis repraesentata: sumendo ea potissimum subjecta quae et inter ea quae quaeruntur sunt nobilissima et inter se maxime

diversa; ut in unoquoque genere exemplum non desit. Neque de iis exemplis loquimur quae singulis praeceptis ac regulis illustrandi gratia adjiciuntur (hoc enim in secunda parte operis abunde praestitimus); sed plane typos intelligimus et plasmata, quae universum mentis processum atque inveniendi continuatam fabricam et ordinem, in certis subjectis, iisque variis et insignibus, tanquam sub oculos ponant. Etenim nobis in mentem venit, in mathematicis, astante machina, sequi demonstrationem facilem et perspicuam; contra absque hac commoditate, omnia videri involuta et, quam revera sunt, subtiliora. Itaque hujusmodi exemplis quartam partem nostri operis attribuimus: quae revera nil aliud est, quam secundae partis applicatio particularis et explicata.

At quinta pars ad tempus tantum, donec reliqua perficiantur, adhibetur; et tanquam foenus redditur, usque dum sors haberi possit. Neque enim finem nostrum ita petimus occaecati, ut quae occurrunt in via utilia negligamus. Quamobrem quintam partem operis ex iis conficimus quae a nobis aut inventa aut probata aut addita sunt; neque id tamen ex rationibus atque praescriptis interpretandi, sed ex eodem intellectus usu quem alii in inquirendo et inveniendo adhibere consueverunt. Etenim cum, ex perpetua nostra cum natura consuetudine, majora de meditationibus nostris quam pro ingenii viribus speramus; tum poterunt ista veluti tabernaculorum in via positorum vice fungi, ut mens ad certiora contendens in iis paulisper acquiescat. Attamen testamur interim, nos illis ipsis, quod ex vera interpretandi forma non sint inventa aut probata, teneri minime velle. Istam vero judicii suspensionem non est quod exhorreat quispiam, in doctrina quae non simpliciter nil sciri posse, sed nil nisi certo ordine et certa via sciri posse, asserit; atque interea tamen certos certitudinis gradus ad usum et levamen constituit, donec mens in causarum explicatione consistat. Neque enim illae ipsae scholae philosophorum qui *Acatalepsiam* simpliciter tenuerunt inferiores fuere istis quae pronuntiandi licentiam usurparunt. Illae tamen sensui et intellectui auxilia non paraverunt, quod nos fecimus, sed fidem et authoritatem plane sustulerunt; quod longe alia res est, et fere opposita.

Sexta tandem pars operis nostri (cui reliquae inserviunt ac ministrant) eam demum recludit et proponit philosophiam, quae ex hujusmodi (qualem ante docuimus et paravimus) inquisitione legitima et casta et severa educitur et constituitur. Hanc vero postremam partem perficere et ad exitum perducere, res est et supra vires et ultra spes nostras collocata. Nos ei initia (ut speramus) non contemnenda, exitum generis humani fortuna dabit, qualem forte homines in hoc rerum et animorum statu haud facile animo capere aut metiri queant. Neque enim agitur solum foelicitas contemplativa, sed vere res humanae et fortunae, atque omnis operum potentia. Homo enim naturae minister et interpres tantum facit et intelligit, quantum de naturae ordine, opere vel mente, observaverit: nec amplius scit, aut potest. Neque enim ullae vires causarum catenam solvere aut perfringere possint; neque natura aliter quam parendo vincitur. Itaque intentiones geminae illae, humanae scilicet *Scientiae* et *Potentiae*, vere in idem coincidunt; et frustratio operum maxime fit ex ignoratione causarum.

Atque in eo sunt omnia, siquis oculos mentis a rebus ipsis nunquam dejiciens, earum imagines plane ut sunt excipiat. Neque enim hoc siverit Deus, ut phantasiae nostrae somnium pro exemplari mundi edamus: sed potius benigne faveat, ut apocalypsim ac veram visionem vestigiorum et sigillorum creatoris super creaturas scribamus.

Itaque Tu Pater, qui lucem visibilem primitias creaturae dedisti, et lucem intellectualem ad fastigium operum tuorum in faciem hominis inspirasti; opus hoc, quod a tua bonitate profectum tuam gloriam repetit, tuere et rege. Tu postquam conversus es ad spectandum opera quae fecerunt manus tuae, vidisti quod omnia essent bona valde; et requievisti. At homo conversus ad opera quae fecerunt manus suae, vidit quod omnia essent vanitas et vexatio spiritus; nec ullo modo requievit. Quare si in operibus tuis sudabimus, facies nos visionis tuae et sabbati tui participes. Supplices petimus, ut haec mens nobis constet; utque novis eleemosynis, per manus nostras et aliorum quibus eandem mentem largieris, familiam humanam dotatam velis.

DEEST PARS PRIMA

INSTAURATIONIS,

QUAE COMPLECTITUR

PARTITIONES SCIENTIARUM.

Illae tamen ex Secundo Libro de Progressibus faciendis in Doctrina Divina et Humana, *nonnulla ex parte peti possunt.*

SEQUITUR SECUNDA PARS

INSTAURATIONIS,

QUAE ARTEM IPSAM

Interpretandi Naturam, et verioris adoperationis Intellectus exhibet: neque eam ipsam tamen in Corpore tractatus justi, sed tantum digestam per summas, in Aphorismos.

PARS SECUNDA OPERIS,

QUAE DICITUR

NOVUM ORGANUM,

SIVE

INDICIA VERA

DE INTERPRETATIONE

NATURAE.

PRAEFATIO.

Qui de natura, tanquam de re explorata, pronuntiare ausi sunt, sive hoc ex animi fiducia fecerint sive ambitiose et more professorio, maximis illi philosophiam et scientias detrimentis affecere. Ut enim ad fidem faciendam validi, ita etiam ad inquisitionem extinguendam et abrumpendam efficaces fuerunt. Neque virtute propria tantum profuerunt, quantum in hoc nocuerunt, quod aliorum virtutem corruperint et perdiderint. Qui autem contrariam huic viam ingressi sunt atque nihil prorsus sciri posse asseruerunt, sive ex sophistarum veterum odio sive ex animi fluctuatione aut etiam ex quadam doctrinae copia in hanc opinionem delapsi sint, certe non contemnendas ejus rationes adduxerunt; veruntamen nec a veris initiis sententiam suam derivarunt, et, studio quodam atque affectatione provecti, prorsus modum excesserunt. At antiquiores ex Graecis (quorum scripta perierunt) inter pronuntiandi jactantiam et *Acatalepsiae* desperationem prudentius se sustinuerunt: atque de inquisitionis difficultate et rerum obscuritate saepius querimonias et indignationes miscentes, et veluti fraenum mordentes, tamen propositum urgere atque naturae se immiscere non destiterunt; consentaneum (ut videtur) existimantes, hoc ipsum (videlicet utrum aliquid sciri possit) non disputare, sed experiri. Et tamen illi ipsi, impetu tantum intellectus usi, regulam non adhibuerunt, sed omnia in acri meditatione et mentis volutatione et agitatione perpetua posuerunt.

Nostra autem ratio, ut opere ardua, ita dictu facilis est. Ea enim est, ut certitudinis gradus constituamus, sensum per reductionem quandam tueamur, sed mentis opus quod sensum subsequitur plerunque rejiciamus; novam autem et certam viam, ab ipsis sensuum perceptionibus, menti aperiamus et muniamus. Atque hoc proculdubio viderunt et illi qui tantas dialecticae partes tribuerunt. Ex quo liquet, illos intellectui adminicula quaesivisse, mentis autem processum nativum et sponte moventem, suspectum habuisse. Sed serum plane rebus perditis hoc adhibetur remedium; postquam mens ex quotidiana vitae consuetudine, et auditionibus et doctrinis inquinatis occupata, et vanissimis *idolis* obsessa

fuerit. Itaque ars illa dialecticae, sero (ut diximus) cavens, neque rem ullo modo restituens, ad errores potius figendos quam ad veritatem aperiendam valuit. Restat unica salus ac sanitas, ut opus mentis universum de integro resumatur; ac mens, jam ab ipso principio, nullo modo sibi permittatur, sed perpetuo regatur; ac res veluti per machinas conficiatur. Sane si homines opera mechanica nudis manibus, absque instrumentorum vi et ope, aggressi essent, quemadmodum opera intellectualia nudis fere mentis viribus tractare non dubitarunt, parvae admodum fuissent res quas movere et vincere potuissent, licet operas enixas atque etiam conjunctas praestitissent. Atque si paulisper morari, atque in hoc ipsum exemplum, veluti in speculum, intueri velimus; exquiramus (si placet) si forte obeliscus aliquis magnitudine insignis ad triumphi vel hujusmodi magnificentiae decus transferendus esset, atque id homines nudis manibus aggrederentur, annon hoc magnae cujusdam esse dementiae spectator quispiam rei sobrius fateretur? Quod si numerum augerent operariorum, atque hoc modo se valere posse confiderent, annon tanto magis? Sin autem delectum quendam adhibere vellent, atque imbecilliores separare, et robustis tantum et vigentibus uti, atque hinc saltem se voti compotes fore sperarent, annon adhuc eos impensius delirare diceret? Quin etiam si hoc ipso non contenti, artem tandem athleticam consulere statuerent, ac omnes deinceps manibus et lacertis et nervis ex arte bene unctis et medicatis adesse juberent, annon prorsus eos dare operam ut cum ratione quadam et prudentia insanirent, clamaret? Atque homines tamen simili malesano impetu et conspiratione inutili feruntur in intellectualibus; dum ab ingeniorum vel multitudine et consensu vel excellentia et acumine magna sperant, aut etiam dialectica (quae quaedam athletica censeri possit) mentis nervos roborant; sed interim, licet tanto studio et conatu, (si quis vere judicaverit) intellectum nudum applicare non desinunt. Manifestissimum autem est, in omni opere magno, quod manus hominis praestat, sine instrumentis et machinis, vires nec singulorum intendi nec omnium coire posse.

Itaque ex his quae diximus praemissis, statuimus duas esse res de quibus homines plane monitos volumus, ne forte illae

eos fugiant aut praetereant. Quarum prima hujusmodi est; fieri fato quodam (ut existimamus) bono, ad extinguendas et depellendas contradictiones et tumores animorum, ut et veteribus honor et reverentia intacta et imminuta maneant, et nos destinata perficere et tamen modestiae nostrae fructum percipere possimus. Nam nos, si profiteamur nos meliora afferre quam antiqui, eandem quam illi viam ingressi, nulla verborum arte efficere possimus, quin inducatur quaedam ingenii vel excellentiae vel facultatis comparatio sive contentio; non ea quidem illicita aut nova; — quidni enim possimus pro jure nostro (neque eo ipso alio, quam omnium) si quid apud eos non recte inventum aut positum sit, reprehendere aut notare?—sed tamen utcunque justa aut permissa, nihilominus impar fortasse fuisset ea ipsa contentio, ob virium nostrarum modum. Verum quum per nos illud agatur, ut alia omnino via intellectui aperiatur illis intentata et incognita, commutata jam ratio est; cessant studium et partes; nosque indicis tantummodo personam sustinemus, quod mediocris certe est authoritatis, et fortunae cujusdam potius quam facultatis et excellentiae. Atque haec moniti species ad personas pertinet; altera ad res ipsas.

Nos siquidem de deturbanda ea quae nunc floret philosophia, aut si quae alia sit aut erit hac emendatior aut auctior, minime laboramus. Neque enim officimus, quin philosophia ista recepta, et aliae id genus, disputationes alant, sermones ornent, ad professoria munera et vitae civilis compendia adhibeantur et valeant. Quin etiam aperte significamus et declaramus, eam quam nos adducimus philosophiam ad istas res admodum utilem non futuram. Non praesto est, neque in transitu capitur, neque ex praenotionibus intellectui blanditur, neque ad vulgi captum nisi per utilitatem et effecta descendet.

Sint itaque (quod foelix faustumque sit utrique parti) duae doctrinarum emanationes, ac duae dispensationes; duae similiter contemplantium sive philosophantium tribus ac veluti cognationes; atque illae neutiquam inter se inimicae aut alienae, sed foederatae et mutuis auxiliis devinctae: sit denique alia scientias colendi, alia inveniendi ratio. Atque quibus prima potior et acceptior est, ob festinationem, vel

vitae civilis rationes, vel quod illam alteram ob mentis infirmitatem capere et complecti non possint (id quod longe plurimis accidere necesse est), optamus ut iis foeliciter et ex voto succedat quod agunt, atque ut quod sequuntur teneant. Quod si cui mortalium cordi et curae sit, non tantum inventis haerere atque iis uti, sed ad ulteriora penetrare; atque non disputando adversarium, sed opere naturam vincere; denique, non belle et probabiliter opinari, sed certo et ostensive scire; tales, tanquam veri scientiarum filii, nobis (si videbitur) se adjungant; ut omissis naturae atriis, quae infiniti contriverunt, aditus aliquando ad interiora patefiat. Atque ut melius intelligamur, utque illud ipsum quod volumus ex nominibus impositis magis familiariter occurrat, altera ratio sive via *Anticipatio Mentis*, altera *Interpretatio Naturae*, a nobis appellari consuevit.

Est etiam quod petendum videtur. Nos certe cogitationem suscepimus et curam adhibuimus, ut quae a nobis proponentur non tantum vera essent, sed etiam ad animos hominum (licet miris modis occupatos et interclusos) non incommode aut aspere accederent. Veruntamen aequum est, ut ab hominibus impetremus (in tanta praesertim doctrinarum et scientiarum restauratione) ut qui de hisce nostris aliquid, sive ex sensu proprio, sive ex authoritatum turba, sive ex demonstrationum formis (quae nunc tanquam leges quaedam judiciales invaluerunt), statuere aut existimare velit, ne id in transitu et velut aliud agendo facere se posse speret; sed ut rem pernoscat; nostram, quam describimus et munimus, viam ipse paullatim tentet; subtilitati rerum quae in experientia signata est assuescat; pravos denique atque alte haerentes mentis habitus tempestiva et quasi legitima mora corrigat; atque tum demum (si placuerit) postquam in potestate sua esse coeperit, judicio suo utatur.

SEQUITUR

PARTIS SECUNDAE SUMMA,

DIGESTA

IN APHORISMOS.

PARTIS SECUNDAE

SUMMA,

DIGESTA

IN

APHORISMOS.

SUMMARY OF BOOK I.

THE First Book of the Novum Organum, which was designed to be a sort of introduction to the whole work, is called in the Partis Secundae Delineatio (Ellis and Spedding, vol. iii. p. 552) 'pars praeparans,' in opposition to the 'pars informans,' which was to be comprised in the remaining books. The following brief account of its contents may be of service to the reader. Aphs. 1–31 consist of certain preliminary remarks, chiefly on the futility of the methods of enquiry at present in use and the necessity of a more faithful study of Nature. In Aphs. 32–37, he makes a kind of apology for the introduction of a new method. Aphs. 38–70 contain the doctrine of the Idola, to which Bacon justly attaches the utmost importance. 'Primo enim mentis area aequanda, et liberanda ab eis quae hactenus recepta sunt.' (Partis Secundae Delineatio, Ellis and Spedding, vol. iii. p. 548.) Then follow the signs, five in number, of the weakness and inutility of preceding philosophies (Aphs. 71–77). These are followed by the causes, fifteen in number, of so long continuance in error (Aphs. 78–92). In the middle of Aphorism 92, he passes on to the Grounds of Hope in the future progress of Science. These are twenty-one, and occupy Aphs. 92–115. The next three Aphorisms contain three cautions or warnings. Aphs. 119–121 contain three apologies. Then follow the answers to four possible objections (Aphs. 122–126). The next Aphorism is of great importance, as vindicating for the application of his method not only the field of natural, but also that of moral and mental science. The remainder of the Book (Aphs. 128–130) consists of certain miscellaneous remarks, forming the transition to Book ii.

APHORISMI

DE INTERPRETATIONE

NATURAE

ET REGNO HOMINIS.

APHORISMUS.

I.

HOMO, naturae minister et interpres, tantum facit et intelligit quantum de naturae ordine re vel mente observaverit: nec amplius scit, aut potest[1].

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[1] 'Man, the servant and interpreter of Nature, does and understands just so much as he has discerned concerning the order of nature by observation or reflection (*or* by the observation of things or of himself): nor does he know more, or can he do more.'

The precise meaning of the words *re vel mente observaverit* is not clear. The distinction intended may be either, as I am inclined to think is the case, between the observation of facts and the subsequent process of meditation or reflection on such observation, or between the observation of the external world and that of our own minds, external and internal perception, as they have been called. According to either interpretation, the passage will remind the reader of the main positions in Locke's Essay, to which it might well serve as a motto. Though the precise meaning of the words is obscure, the purport of the Aphorism is plain. Man, if he would learn or do anything, must carefully watch the processes of Nature, must register and interpret her phenomena. This is his only way either to knowledge or power.

The same sentence, with a slight variation, occurs towards the end of the Distributio Operis. Its connection in that place with the preceding and succeeding sentences is worthy of notice. 'Neque enim agitur solum felicitas contemplativa, sed vere res humanae et fortunae, atque omnis operum potentia. Homo enim naturae minister et interpres tantum facit et intelligit, quantum de naturae ordine, *opere* vel mente, observaverit: nec amplius scit, aut potest. Neque enim ullae vires causarum catenam solvere aut perfringere possint, neque natura aliter quam parendo vincitur.'

II.

Nec manus nuda, nec intellectus sibi permissus, multum valet; instrumentis et auxiliis res perficitur; quibus opus est, non minus ad intellectum, quam ad manum. Atque ut instrumenta manus motum aut cient aut regunt; ita et instrumenta mentis intellectui aut suggerunt aut cavent.

III.

Scientia et potentia humana in idem coincidunt[2], quia ignoratio causae destituit effectum. Natura enim non nisi parendo vincitur[3]: et quod in contemplatione instar causae est, id in operatione instar regulae est.

IV.

Ad opera nil aliud potest homo, quam ut corpora naturalia admoveat et amoveat: reliqua natura intus transigit[4].

V.

Solent se immiscere naturae (quoad opera[5]) mechanicus, mathematicus, medicus, alchemista, et magus; sed omnes (ut nunc sunt res) conatu levi, successu tenui[6].

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[2] The same thought is often briefly expressed in English under the form: 'Knowledge is Power.' It may be remarked that Power always implies Knowledge, but Knowledge does not always give power. To do a thing, we must know how to do it, but there are some departments of knowledge which, however interesting in themselves or valuable as instruments of mental discipline, do not appear to increase our power over Nature.

Bacon seldom loses any opportunity of insisting on the practical applications of science. Professor Playfair truly remarks that the want of connection between the sciences and arts was one of the principal defects which Bacon deplored in the philosophy of his time.

[3] We must patiently observe Nature, if we wish to acquire any control over her operations. Our 'rules' are merely copies and adaptations of the 'causes' which we see at work in the external world. The same sentence, slightly altered, is repeated in Aphorism 129. See note on it in that place.

[4] We cannot create; we can only combine or separate bodies already existing. 'In Art,' says Playfair, 'man does nothing more than bring things nearer to one another, or carry them farther off; the rest is performed by Nature, and on most occasions by means of which we are quite ignorant.'

[5] So far as concerns the active or operative part of knowledge, that is to say, Art as distinguished from Science.

[6] Mr. Kitchin has the following note: 'As to the Mechanician, the Mathematician and the Physician, Bacon's remarks were being falsified at

VI.

Insanum quiddam esset, et in se contrarium, existimare ea, quae adhuc nunquam facta sunt, fieri posse, nisi per modos adhuc nunquam tentatos.

VII.

Generationes mentis et manus numerosae admodum videntur in libris et opificiis. Sed omnis ista varietas sita est in subtilitate eximia, et derivationibus paucarum rerum, quae innotuerunt; non in numero axiomatum [7].

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the very time he wrote.—Mechanics had produced fly-clocks, telescopes, and other useful contrivances.—Mathematics boasted of Kepler and Galileo; and the discoveries of Harvey and Gilbert were opening out a new world for Medical research. But Bacon could scarcely have discerned all this, and his jealousy' (or, as I should rather say, distrust) 'of his contemporaries (cf. I. 54) would scarcely have allowed him to acknowledge their worth. Besides this he was utterly ignorant of Mathematics (see Hallam, Lit. Eur. vol. II. iii. 3. § 78). Alchemy was certainly thoroughly empirical and faulty; for "at this time Chemistry seemed to have an elective attraction for everything that was absurd and unfounded." (Playfair.) And Magic, which still exerted great influence, was as bad. Sir T. Browne, Rel. Med. i. 31, gives some account of it; which is worth consulting as it gives the views of a physician and contemporary of Bacon. Cf. also De Augm. Sc. iii. 5, and Adv. of Learning, Bk. ii.'

In Aph. 85, Bacon distinguishes between Natural and Superstitious Magic. Natural Magic is treated in the De Augmentis, lib. iii. cap. 5, as supplementary to the Inquisition of Forms, and vindicated, when distinguished from the 'false and ignoble kind,' as a legitimate branch of enquiry. 'Si igitur desiderari eam partem Metaphysicae quae de *Formis* agit posuimus, sequitur ut *Naturalis* etiam *Magia*, quae ad eam est relativa, similiter desideretur. Verum hoc loco postulandum videtur, ut vocabulum istud *Magiae*, in deteriorem partem jampridem acceptum, antiquo et honorifico sensui restituatur. Etenim *Magia* apud Persas pro sapientia sublimi, et scientia consensuum rerum universalium, accipiebatur; atque etiam tres illi reges, qui ab Oriente ad Christum adorandum venerunt, *Magorum* nomine vocabantur. Nos vero eam illo in sensu intelligimus, ut sit scientia quae cognitionem *Formarum Abditarum* ad opera admiranda deducat; atque, quod dici solet, *activa cum passivis conjungendo* magnalia naturae manifestet.'

The substance of this Aphorism, greatly expanded, occupies the two first paragraphs of the Cogitata et Visa. These paragraphs are too long to be extracted, but they may be read by the student with advantage. See also Filum Labyrinthi sive Formula Inquisitionis, ad init. (E. and S., vol. iii. pp. 496, 497).

[7] The word Axioma is used by Bacon of any general proposition. In Aphorism 103, Axiomata are contrasted with 'Opera' and 'particularia.'

VIII.

Etiam opera, quae jam inventa sunt, casui debentur et

In Aphorism 104, he speaks of 'axiomata generalissima' ('qualia sunt principia, quae vocant, artium et rerum'), 'axiomata media,' and 'axiomata minora' or 'infima.' Of the last he says, 'Etenim axiomata infima non multum ab experientia nuda discrepant.'

In the works of Aristotle, the word ἀξίωμα, even when confined to its logical sense, is employed in no less than three significations. Sometimes it is used for any proposition whatever, as, for instance, in Topics, ix. or Soph. El., 24 (ed. Bekker, p. 179 b. 12–15): αὕτη δ' οὐκ ἔσται, ἄν τις μὴ ἐπὶ τοῦ εἰδέναι ἀλλ' ἐπὶ τοῦ εἶναι ἢ πῶς ἔχειν τὸ αὐτὸ ἀξίωμα λαμβάνῃ, οἷον εἰ ὅδε ἐστὶ πατήρ, ἔστι δὲ σός. Cp. Topics, viii. 1 (p. 156 a. 23), viii. 3 (p. 159 a. 4, 5). Secondly, Aristotle shews that he is aware of the signification in which the term was employed by mathematicians, who then, as now, designated the first principles of their science as 'axioms.' Λεκτέον δὲ πότερον μιᾶς ἢ ἑτέρας ἐπιστήμης περί τε τῶν ἐν τοῖς μαθήμασι καλουμένων ἀξιωμάτων καὶ περὶ τῆς οὐσίας. Metaphysics, iii. 3 (1005 a. 19–21). Lastly, he employs the term in a peculiarly technical sense of his own, to designate those ultimate principles or postulates which are necessary not to the knowledge of this or that particular science but to any knowledge whatsoever. In this sense, ἀξιώματα are contrasted with θέσεις, the first principles of this or that particular science. Ἀμέσου δ' ἀρχῆς συλλογιστικῆς θέσιν μὲν λέγω ἣν μὴ ἔστι δεῖξαι, μηδ' ἀνάγκη ἔχειν τὸν μαθησόμενόν τι· ἣν δ' ἀνάγκη ἔχειν τὸν ὁτιοῦν μαθησόμενον, ἀξίωμα· ἔστι γὰρ ἔνια τοιαῦτα· τοῦτο γὰρ μάλιστ' ἐπὶ τοῖς τοιούτοις εἰώθαμεν ὄνομα λέγειν. An. Post. i. 2 (p. 72 a. 14–18). Cp. i. 10. As an example of 'Axioms' in this sense may be adduced the 'Law of Contradiction,' which Aristotle describes (Metaphysics, iii. 3, p. 1005 b. 33, 34) as φύσει ἀρχὴ καὶ τῶν ἄλλων ἀξιωμάτων πάντων.

Some logicians, especially those of the school of Ramus, use the word Axioma as the equivalent of Propositio or Judicium. Thus Milton (Ars Logica, lib. ii. cap. 2) defines and defends this use of the word as follows: 'Axioma est dispositio argumenti cum argumento[1], qua esse aliquid aut non esse indicatur. Axioma saepe Aristoteli significat propositionem sive sententiam ita claram, ut quasi digna sit cui propter se fides habeatur. Alias axioma et propositionem sive sententiam quamlibet pro eodem is habet: et recte quidem: ut enim sententia a sentio, i. e. existimo vel arbitror, ita axioma a verbo Graeco quod idem significat, derivatur. Atque hujus vocis generalem hanc significationem apud veteres Dialecticos receptam fuisse, ex Cicerone, Plutarcho, Laertio, Gellio, Galeno lib. xvi. c. 8 etc. constat.' Cicero, following the Stoics, appears invariably to use the word in this sense. 'Nempe fundamentum dialecticae est, quidquid enuntietur (id autem appellant ἀξίωμα, quod est quasi effatum) aut verum esse aut falsum.' Acad. II. 29. 'Omne *pronuntiatum* (sic enim mihi in praesentia occurrit, ut appellarem ἀξίωμα; utar post alio, si invenero melius) id ergo est pronuntiatum, quod est verum aut falsum.' Tusc. i. 7. Bacon's usage of

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[1] 'Argumentum autem cum argumento est id quod arguit cum eo quod arguitur.'

experientiae[8], magis quam scientiis: scientiae enim, quas nunc habemus, nihil aliud sunt quam quaedam concinnationes rerum antea inventarum; non modi inveniendi, aut designationes novorum operum.

IX.

Causa vero et radix fere omnium malorum in scientiis ea una est; quod dum mentis humanae vires falso miramur et extollimus, vera ejus auxilia non quaeramus.

X.

Subtilitas naturae subtilitatem sensus et intellectus multis partibus superat[9]; ut pulchrae illae meditationes et specula-

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the word seems to differ from this only in restricting it to general propositions, that is, in excluding the 'axioma particulare' and the 'axioma proprium' of the Ramists.

The word is frequently restricted to self-evident propositions, whether common to all sciences, or peculiar to some particular science. Thus Chauvin in his Lexicon Philosophicum defines an Axiom as 'sententia generalis cuilibet attendenti nota,' and we commonly speak of truths, which require no proof, as 'axiomatic.'

Newton's use of the word appears to be less general than that of Bacon. Though he does not restrict it to self-evident propositions, or to those truths which are common to all sciences, he appears to use it exclusively of the first principles of any particular science. Thus, in the Principia, he speaks of the 'Axiomata sive Leges Motus,' and at the beginning of the Optics he enumerates five Axioms, such as that 'The Angles of Reflexion and Refraction lie in one and the same Plane with the Angle of Incidence,' 'The Angle of Reflexion is equal to the Angle of Incidence,' etc. These would answer to the 'Axiomata Generalissima' of Bacon.

We have seen that Cicero proposes the word 'pronuntiatum' as a translation of *ἀξίωμα* in its more general sense, when used as the equivalent of proposition. The words 'maxim,' 'principle,' or 'dignitas' sometimes replace it in its more restricted senses.

The student will find a long note on the etymology and meaning of the word 'Axiom' in Hamilton's edition of Reid, pp. 764–6.

[8] *ἐμπειρία*, empiricism, mere experience, as distinguished from properly directed observation and experiment. For a distinction between the different kinds of experience and their bearing on discovery, see De Augmentis, lib. v. cap. 2.

[9] Mr. Kitchin here very appositely quotes Aristotle, Metaph. *a*. 1. *Ἴσως δὲ καὶ τῆς χαλεπότητος οὔσης κατὰ δύο τρόπους, οὐκ ἐν τοῖς πράγμασιν, ἀλλ' ἐν ἡμῖν τὸ αἴτιον αὐτῆς. Ὥσπερ γὰρ καὶ τὰ τῶν νυκτερίδων ὄμματα πρὸς τὸ φέγγος ἔχει τὸ μεθ' ἡμέραν, οὕτω καὶ τῆς ἡμετέρας ψυχῆς ὁ νοῦς πρὸς τὰ τῇ φύσει φανερώτατα πάντων.*

tiones humanae et causationes[10] res malesana sint, nisi quod non adsit qui advertat[11].

XI.

Sicut scientiae[12], quae nunc habentur, inutiles sunt ad inventionem operum; ita et logica, quae nunc habetur, inutilis est ad inventionem scientiarum.

To the same effect we find a passage in Galileo's Dialogo dei Massimi Sistemi, Giornata Prima (Sir Thomas Salusbury's Translation, pp. 84, 85): *Sagredus.* 'I ever accounted extraordinary madness that of those who would make human comprehension the measure of what nature hath a power or knowledge to effect; whereas on the contrary there is not any the least effect in Nature, which can be fully understood by the most speculative wits in the world. This their so vain presumption of knowing all, can take beginning from nothing, unless from their never having known anything; for if one hath but once only experienced the perfect knowledge of one only thing, and but truly tasted what it is to know, he shall perceive that of infinite other conclusions, he understands not so much as one.'

[10] A post-classical word. 'Controversies.' Du Cange explains it as 'Lis, controversia, placitum,' and, amongst other authorities, quotes Gregor. Magn. lib. i. epist. 9: 'Fines, de quibus causatio mota est;' Concilium Arelatense, an. 813. can. 16: 'Ne in Dominicis diebus publicae mercatae, neque causationes disceptationesque exerceantur.'

The word occurs in the sense of an 'excuse' or 'apology' as early as the time of Aulus Gellius ('Atque id fecerunt ne causatio ista aegri corporis perpetuam vacationem daret fidem detrectantibus, jurisque actiones declinantibus,' Noctes Atticae, lib. xx. cap. 1), but that does not seem to be its meaning in this place.

[11] We cannot place ourselves sufficiently apart from the crowd in which we move, to obtain anything like an adequate idea of its eccentricities and delusions.

[12] Aphorisms xi–xiv should be considered in connection with each other. They contain the sum of Bacon's complaint against the old logic. Though the scholastic logic recognised Induction as a form of reasoning, it failed to see its importance, and had not attempted to lay down any rules for its employment. Hence, practically, it was exclusively a syllogistic logic. Now it is the function of syllogism to develope the consequences of a principle, not to examine the principle itself. But, unless we examine the principle, how can we be certain of the truth of the consequences? We may only be multiplying error instead of truth. The conclusion of every new syllogism may be only one error the more, and, from the false confidence which the mere reiteration of a proposition begets in the mind, a principle which at first was received with hesitation may come to be regarded as unassailable, and be assumed as placed beyond all doubt. When men have reared a vast superstructure of reasoning, they are naturally unwilling to examine the foundations. What is

XII.

Logica, quae in usu est, ad errores (qui in notionibus vulgaribus fundantur) stabiliendos et figendos valet, potius quam ad inquisitionem veritatis; ut magis damnosa sit, quam utilis.

XIII.

Syllogismus ad principia scientiarum[13] non adhibetur, ad

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required, then, not in order to replace, but in order to supplement, the old logic, is a logic which shall guarantee the premisses as well as the conclusions, which shall probe the validity of our elementary notions and first principles, as well as develope their ulterior consequences. Such a logic Bacon proposed to supply, or at least to inaugurate.

That Bacon recognised the function of the Syllogism as supplementary to Induction, is evident from several passages of the Novum Organum itself. But perhaps his most explicit statement on this subject is to be found in a letter to Father Baranzan (published in Spedding's Letters and Life of Bacon, vol. vii. pp. 375–7). This letter, which is also interesting on other accounts, contains the following passages:—

'Non est meum abdicare in totum syllogismum. Res est syllogismus magis inhabilis ad praecipua, quam inutilis ad plurima.

'Ad Mathematica quidni adhibeatur? Cum fluxus materiae et inconstantia corporis physici illud sit, quod inductionem desideret; ut per eam veluti figatur, atque inde eruantur notiones bene terminatae.

'De Metaphysica ne sis sollicitus. Nulla enim erit post veram Physicam inventam; ultra quam nihil praeter divina.

'In Physica prudenter notas, et idem tecum sentio, post notiones primae classis, et axiomata super ipsas, per inductionem bene eruta et terminata, tuto adhiberi syllogismum, modo inhibeatur saltus ad generalissima, et fiat progressus per scalam convenientem.'

On the place of Induction in Aristotle's system of logic, we have spoken in the Introduction.

[13] The *ἀρχαί* of Aristotle. That the *ἀρχαί*, being the ultimate major premisses from which syllogism proceeds, do not themselves admit of syllogistic proof, is constantly insisted on by Aristotle. See, for instance, An. Post. i. 2 (72 a. 7), *ἀρχὴ δ' ἐστὶν ἀποδείξεως πρότασις ἄμεσος, ἄμεσος δὲ ἧς μή ἐστιν ἄλλη προτέρα.* He also constantly insists on the fact that these ultimate principles must be gained by induction. See, for instance, Ethics, vi. 3. (3), *Ἐκ προγινωσκομένων δὲ πᾶσα διδασκαλία, ὥσπερ καὶ ἐν τοῖς ἀναλυτικοῖς λέγομεν· ἡ μὲν γὰρ δι' ἐπαγωγῆς, ἡ δὲ συλλογισμῷ. Ἡ μὲν δὴ ἐπαγωγὴ ἀρχή ἐστι καὶ τοῦ καθόλου, ὁ δὲ συλλογισμὸς ἐκ τῶν καθόλου. Εἰσὶν ἄρα ἀρχαὶ ἐξ ὧν ὁ συλλογισμὸς, ὧν οὐκ ἔστι συλλογισμός· ἐπαγωγὴ ἄρα.* Amongst other decisive passages to the same effect may be specially cited An. Post. ii. 19, and Metaph. i. 1.

media axiomata frustra adhibetur[14], cum sit[15] subtilitati naturae longe impar. Assensum itaque constringit, non res.

XIV.

Syllogismus ex propositionibus constat, propositiones ex verbis, verba notionum tesserae sunt[16]. Itaque si notiones ipsae (id quod basis rei est) confusae sint, et temere a rebus abstractae; nihil in iis, quae superstruuntur, est firmitudinis. Itaque spes est una in *inductione* vera[17].

XV.

In notionibus nil sani est, nec in logicis, nec in physicis: non *substantia*, non *qualitas*, *agere*, *pati*, ipsum *esse*, bonae notiones sunt; multo minus *grave*, *leve*, *densum*, *tenue*, *humidum*, *siccum*, *generatio*, *corruptio*, *attrahere*, *fugare*, *elementum*,

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[14] For if the principia scientiarum be uncertain, the axiomata media, which are deduced from them, must, of course, be uncertain as well. We cannot rely on the truth of the conclusion, till we have placed beyond doubt the truth of the premisses.

[15] The reason here assigned applies to both the preceding clauses.

[16] The spoken or written word, it is true, is only the symbol of the notion in the mind of the speaker or writer, but could the notion itself be formed or retained without the use of language? This or that particular word is, of course, separable from the corresponding idea (as is shewn by the mere fact of translation from one language into another), but, without the use of signs of some kind or other, we could hardly think at all. These considerations, however, do not affect the truth of Bacon's criticism. Whether we speak of the ultimate constituents of the syllogism as words or notions, it is essential to all reasoning that we should have a clear understanding of them.

[17] Cp. ii. 19, with the notes on that Aphorism. At first sight, it may not seem plain why it should be the office of Induction to remedy the defect of obscure, false, or inadequate notions. But all notions, we must recollect, involve judgments. In forming or attempting to realise a notion, we really assert a number of propositions. Thus if I put before my mind the notion of gold, I think of it as yellow, malleable, heavy, capable of being exchanged, etc., and, without forming these judgments, I should not realise the notion. Now, when we are dealing with Nature, sound judgments, and, therefore, sound notions can only be gained by observation of facts and a legitimate generalisation from those facts. We may see from what has been said that the Definition of natural objects or qualities (as distinct from merely technical terms) ought always to rest on previous inductions.

materia, *forma*, et id genus; sed omnes phantasticae et male terminatae[18].

XVI.

Notiones infimarum specierum, *hominis*, *canis*, *columbae*, et prehensionum immediatarum sensus, *calidi*, *frigidi*, *albi*, *nigri*, non fallunt magnopere; quae tamen ipsae a fluxu materiae et commissione rerum quandoque confunduntur[19]; reliquae omnes (quibus homines hactenus usi sunt) aberrationes sunt, nec debitis modis a rebus abstractae et excitatae.

XVII.

Nec minor est libido et aberratio in constituendis axiomatibus, quam in notionibus abstrahendis; idque in ipsis principiis, quae ab inductione vulgari[20] pendent. At multo major[21] est in axiomatibus, et propositionibus inferioribus, quae educit syllogismus.

XVIII.

Quae adhuc inventa sunt in scientiis, ea hujusmodi sunt, ut notionibus vulgaribus fere subjaceant: ut vero ad interiora et remotiora naturae penetretur, necesse est ut tam notiones quam axiomata magis certa et munita via a rebus abstrahantur, atque omnino melior et certior intellectus adoperatio in usum veniat.

XIX.

Duae viae[22] sunt, atque esse possunt, ad inquirendam et

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[18] Ill-defined.

[19] It must be recollected that there is no breach of continuity in Nature as there is in our distinctions. Hence, our terms or notions are never exhaustive or adequately representative of the endless varieties of Nature. Mr. Ellis proposes to read commistione for commissione. 'From the context it is clear that Bacon means that the union of bodies of different kinds, by giving rise to new qualities and species intermediate to those for which we have recognised names, tends to confuse our ideas of the latter. I think therefore we ought to read "commistione" for "commissione."'

[20] He is alluding to the Inductio per enumerationem simplicem as distinguished from the Scientific Induction by which he proposes to replace it.

[21] For, by deducing error from error, we recede further and further from the truth.

[22] It should be noticed that even the falsest and flimsiest generalisations about Nature rest upon some slight basis of fact. After observing a few

inveniendam veritatem. Altera a sensu et particularibus advolat ad axiomata maxime generalia, atque ex iis prin-

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particulars, Bacon complains, men usually fly off to the widest generalisations, and then acquiesce in these, as if they were so many indubitable truths. But, in considering this frequent source of error, he does not perceive that rapid generalisation is often indispensable to the scientific enquirer. The fault does not consist so much in making rapid generalisations as in acquiescing too readily and confidently in them, when made. The method of gradual and continuous ascent from particulars to the highest axioms, through all the intermediate steps, which is here commended by Bacon, is not the method which, for the most part, has been actually pursued by the most successful investigators of Nature, nor would its general adoption contribute to the advancement of science. Provided a hypothesis be regarded simply as a hypothesis, and not assumed as true without a rigorous investigation, the mere fact of its generality ought to be no objection to it. Indeed, by stimulating enquiry and directing its course, it is plain that a very general hypothesis, such as the theory of universal gravitation, or Laplace's nebular hypothesis, or the wave-theory of light and sound, or the theory of evolution, or the theory of final causes, even in its cruder forms, may, whether ultimately proved to be true or false, be of the utmost service in the investigation even of small groups of facts. The all-important proviso, of course, is that, *till proved*, such a hypothesis must be taken simply *quantum valeat*, as a hypothesis and no more. It would be far from an advantage to science, to restrain the flights of scientific imagination, but the products of imagination must never be confounded with the results of proof. The fantastic character of the Ancient Physics was due far less to an exuberant imagination than to a defective sense of evidence. And the true remedy was to insist on the necessity of verification rather than on the suppression of hypothesis.

There is, therefore, a third way of investigation which is not open to Bacon's animadversions and which is peculiarly the way of genius. It begins, like the other two, with the observation of particulars, for this always is and must be the first step, and then, by an effort of imagination, frames for itself some explanation which has a far wider range of application than the special class of phenomena which has been observed. This axioma maxime generale is regarded as a hypothesis, to be hereafter proved or disproved, but, meanwhile, it serves as a provisional explanation of the facts, and stimulates to further investigations. From it may be deduced a number of axiomata media which admit of being constantly compared with facts, and thus an ever-increasing experience tends to prove or disprove the axiom in question. If facts do not agree with the deductions from the hypothesis, it must be thrown aside as useless or modified to meet the exceptions; but if it agree with the facts, there is a strong presumption in its favour. Even still, however, it must not be finally admitted as an ascertained truth, till it has been shewn to conform to the rigorous requirements of the inductive methods, or con-

cipiis eorumque immota veritate judicat et invenit axiomata media; atque haec via in usu est. Altera a sensu et particu-

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nected deductively with some still higher generalisations which have been established on independent grounds. When this final step has been taken, the axiomata media deduced from it may be accepted with implicit confidence.

Generally speaking, the axioma maxime generale, even when conceived before the axiomata media, will rest on an induction from these, as its final proof; as these themselves will probably rest on lower axioms, and so on till we reach the axioms which rest on an induction from individual facts. But, in the order of conception, though not in the order of proof, the axioma maxime generale or one of the highest of the intermediate axioms usually comes first, and this circumstance it is which distinguishes the method we are describing from that commended by Bacon.

The history of the Theory of Gravitation supplies an example of a scientific doctrine, the steps of which were established almost in the exact order which Bacon recommends. This may be seen by consulting the Inductive Table of Astronomy given in Dr. Whewell's Novum Organum Renovatum. Moreover, in all sciences this order is the most convenient mode of representing the laws, when once established, though, as we have seen, it is by no means that in which they are always actually established, as a matter of fact. Bearing in mind this qualification, we may adopt the words of Dr. Whewell:—

'We have, indeed, already explained that science consists of Propositions which include the Facts from which they were collected; and other wider Propositions, collected in like manner from the former, and including them. Thus, that the stars, the moon, the sun, rise, culminate, and set, are facts *included* in the proposition that the heavens, carrying with them all the celestial bodies, have a diurnal revolution about the axis of the earth. Again, the observed monthly motions of the moon, and the annual motions of the sun, are *included* in certain propositions concerning the movements of those luminaries with respect to the stars. But all these propositions are really *included* in the doctrine that the earth, revolving on its axis, moves round the sun, and the moon round the earth. These movements, again, considered as facts, are explained and *included* in the statement of the forces which the earth exerts upon the moon, and the sun upon the earth. Again, this doctrine of the forces of these three bodies is *included* in the assertion, that all the bodies of the solar system, and all parts of matter, exert forces, each upon each. And we might easily shew that all the leading facts in astronomy are comprehended in the same generalisation. In like manner with regard to any other science, so far as its truths have been well established and fully developed, we might shew that it consists of a gradation of propositions, proceeding from the most special facts to the most general theoretical assertions.' (Novum Organum Renovatum, ch. vi. § 1.)

Even in Astronomy, however, the heliocentric hypothesis had occurred to the ancients long before the state of their knowledge was sufficient

laribus excitat axiomata, ascendendo continenter et gradatim, ut ultimo loco perveniatur ad maxime generalia; quae via vera est, sed intentata.

XX.

Eandem ingreditur viam (priorem scilicet) intellectus sibi permissus, quam facit ex ordine dialecticae[23]. Gestit enim mens exsilire ad magis generalia, ut acquiescat; et post parvam moram fastidit experientiam: sed haec mala demum aucta sunt a dialectica ob pompas disputationum.

XXI.

Intellectus sibi permissus, in ingenio sobrio et patiente et gravi (praesertim si a doctrinis receptis non impediatur), tentat nonnihil illam alteram viam, quae recta est, sed exiguo profectu; cum intellectus, nisi regatur et juvetur, res inaequalis[24] sit, et omnino inhabilis ad superandam rerum obscuritatem.

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to supply them with sound arguments for it; nor, even in the time of Copernicus himself, was it more than the simplest and most consistent explanation of known facts.

The student is specially recommended to read Mr. Mill's strictures on this Aphorism. See Mill's Logic, bk. vi. ch. 5. § 5. On the other side, he may refer to Dr. Whewell's Philosophy of Discovery, ch. xxii. § 56–62.

In extenuation of Bacon's error, for such I conceive it to be, may be pleaded the exceedingly vague and unsatisfactory character of the 'axiomata maxime generalia' which were in vogue in his time. As proof of this, I may cite the list which Mr. Mill himself gives at the beginning of the 24th chapter of his Examination of Sir W. Hamilton's Philosophy.

Notwithstanding all that is said here and in other places, Bacon himself has recourse to hypothesis (under the name of 'permissio intellectus') in II. 20. The view which he there takes of its relation to Induction is far more just than that here taken. See my note on the beginning of that Aphorism.

[23] The mind is naturally prone to the false method, and is encouraged in its tendencies by the use of the vulgar logic, which fails to insist on the examination of first principles. This proneness of the mind to rest in first principles, however obtained, and to resent any examination of them, is due mainly to a combination of pride with mental indolence. We recoil from the trouble of reviewing what lies at the bottom of so many of our beliefs, and we are too proud to acknowledge that we have been so long or so frequently in error. To a certain extent, also, it may be accounted for by the principle of association. We have ourselves repeated, or heard the maxim repeated by others, so frequently, and in connection with so many other propositions which we accept as true, that we can hardly conceive it being called in question.

[24] This word may perhaps be translated 'inadequate,' or perhaps

XXII.

Utraque via orditur a sensu et particularibus[25], et acquiescit in maxime generalibus: sed immensum quiddam discrepant; cum altera perstringat tantum experientiam et particularia cursim; altera in iis rite et ordine versetur: altera rursus jam a principio constituat generalia quaedam abstracta et inutilia[26]; altera gradatim exsurgat ad ea quae revera naturae sunt notiora[27].

'irregular,' that is acting sometimes one way, sometimes another. See Mr. Ellis's note.

[25] That, in any case, we begin with particulars furnished by sense, he takes for granted. Cp. Campanella, Metaphysica, pars i. lib. i. Prooemium: 'Principia enim artis, quae intelligimus, sive sint nomina imperfecte naturam rei significantia, sive sint definitiones, perfecte eandem significantes, sive propositiones universales, a sensu accepimus per inductionem, quod et Aristoteles in 2 Poster. docet, licet sui oblitus.'

[26] Such as that 'Nature does nothing in vain,' 'Nature abhors a vacuum,' that each body has only one proper motion, and the like.

[27] The phrase 'naturae notiora' is a scholastic mistranslation of Aristotle's *τῇ φύσει γνωριμώτερα*, which ought to be translated 'natura notiora;' *τῇ φύσει* or *ἁπλῶς γνωριμώτερα* are opposed to *ἡμῖν γνωριμώτερα* as the more general to the more particular, as universals to objects of sense. Amongst other places, see Post. An. i. 2 (p. 71 b. 33—p. 72 a. 5): *Πρότερα δ' ἐστὶ καὶ γνωριμώτερα διχῶς· οὐ γὰρ ταὐτὸν πρότερον τῇ φύσει καὶ πρὸς ἡμᾶς πρότερον, οὐδὲ γνωριμώτερον καὶ ἡμῖν γνωριμώτερον. Λέγω δὲ πρὸς ἡμᾶς μὲν πρότερα καὶ γνωριμώτερα τὰ ἐγγύτερον τῆς αἰσθήσεως, ἁπλῶς δὲ πρότερα καὶ γνωριμώτερα τὰ πορρώτερον. Ἔστι δὲ πορρωτάτω μὲν τὰ καθόλου μάλιστα, ἐγγυτάτω δὲ τὰ καθ' ἕκαστα· καὶ ἀντίκειται ταῦτ' ἀλλήλοις.* The student may with advantage read Trendelenburg's note on this passage. See notes to the Elementa Logices Aristoteleae, § 19.

Naturally, or in reference to Nature, according to Aristotle's way of thinking, the universal is prior to the individual, the cause to the effect, the general law to the particular fact. By or in reference to us, on the other hand, the individual is better known than the universal, the effect than the cause, the particular fact than the general law. Nature indeed may be regarded as ever striving to reproduce the type in the individual, to represent the general law in its special manifestations, to carry out the cause into its effects. And so, by a figure of speech, it may be said to have a better or prior knowledge of that which, in our case, comes last, and as the result of a variety of mental operations.

Bacon here, as elsewhere, avails himself of the Aristotelian distinction, but seems to imply that with Aristotle the *τῇ φύσει γνωριμώτερα* were mere useless abstractions, while he himself probably understands by the 'revera naturae notiora' those ultimate causes or Forms, out of which, as a sort of alphabet, he conceived that the various bodies, forces, and

XXIII.

Non leve quiddam interest inter humanae mentis *idola*[28], et divinae mentis ideas[29]; hoc est, inter placita quaedam inania, et veras signaturas atque impressiones factas in creaturis, prout inveniuntur.

XXIV.

Nullo modo fieri potest, ut axiomata per argumentationem

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qualities in nature were composed. For the further explanation of these 'Forms,' the student must refer to the Introduction.

Mr. Spedding notices that, in his English writings, Bacon seems to use the word 'original' as equivalent to 'naturae notior.'

It is interesting to compare with this Aphorism the following passage of the Distributio Operis: 'At secundum nos, axiomata continenter et gradatim excitantur, ut nonnisi postremo loco ad generalissima veniatur: ea vero generalissima evadunt non notionalia, sed bene terminata, et talia quae natura ut revera sibi notiora agnoscat, quaeque rebus haereant in medullis.'

[28] εἴδωλα, 'phantoms' or 'spectres,' not 'idols' in the sense of false gods, as several writers have interpreted it. In the De Augmentis, lib. v. cap. 4, they are called Imagines sive Idola, and in the second of the Two Books on the Advancement of Learning, published in 1605, they are spoken of as 'false appearances that are imposed upon us' by 'the general nature of the mind,' by 'words,' etc. For the latter passage, see Ellis and Spedding's Edition of Bacon's Works, vol. iii. pp. 394–7. Mr. Hallam (Literature of Europe, part iii. ch. 3. § 60) gives some amusing extracts from the authors who have mistaken the meaning of the word.

[29] Are these 'ideas of the divine mind' the 'forms' of which Bacon will speak hereafter? That God created all things in conformity with certain ideas, forms, or exemplars in his own mind, as the sculptor fashions a statue, and that thus, in a certain sense, the world had a pre-existence in the mind of God, is a commonplace of philosophy and theology. Cp. Campanella, Metaphysica, pars i. lib. i. Prooemium: 'Propterea nil est in mundo, quod non aliquid in mente Dei latens idealiter exprimat.' One, though probably not the true, interpretation of the Ideal doctrine of Plato is that the ἰδέαι are simply the ideas or typical forms existing in the mind of God.

By the concluding words of the Aphorism, Bacon probably intends to intimate, as Mr. Kitchin says, 'that it would be futile for Man to endeavour to contemplate any thing abstracted from, and out of its connection with, the material world,' that, in fact, our only mode of ascertaining the ideas of the divine mind is the patient study of the Book of Nature. The Aphorism might be paraphrased thus: God is omniscient; Nature is the reflection of the mind of God. Man, led astray by the phantasms in his own mind, has vainly imagined that he can attain to knowledge, without going to Nature and therein studying the image of the divine mind. Cp. Aph. 124.

constituta ad inventionem novorum operum valeant; quia subtilitas naturae subtilitatem argumentandi multis partibus superat. Sed axiomata, a particularibus rite et ordine abstracta, nova particularia rursus facile indicant et designant [30]; itaque scientias reddunt activas.

XXV.

Axiomata, quae in usu sunt, ex tenui et manipulari experientia, et paucis particularibus, quae ut plurimum occurrunt, fluxere; et sunt fere ad mensuram eorum facta et extensa: ut nil mirum sit, si ad nova particularia non ducant [31]. Quod si forte instantia [32] aliqua, non prius animadversa aut cognita, se offerat, axioma distinctione aliqua frivola salvatur [33], ubi emendari ipsum verius foret.

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[30] Except for the implied limitation to *opera*, this is the true conception of the relations of the Inductive and Deductive methods. When the axioms have been constituted by induction, they should be developed deductively into all their consequences and then ultimately, if they admit of it, applied to practice. The science of Mechanics affords an excellent instance of a science thus constituted, developed, and applied.

The word 'abstracta' as the equivalent of 'inferred by induction' is worthy of notice. The qualities in which a number of individual objects agree are regarded as 'drawn from' them, to the exclusion of those in which they differ, and, therefore, as predicable in an axiom or proposition of the class as a whole. Properly speaking, however, the word 'abstraced' ought to be applied, not to the qualities on which the attention is concentrated, but to those which are withdrawn from consideration. Attention and Abstraction are processes the reverse of and complementary to each other.

[31] The existing Axioms are founded on a small number of instances, of common occurrence, and just fit those instances, but are employed as if they were universally true, other instances to the contrary either not being taken into account or being explained away by some frivolous distinction. In other words, an empirical law is employed as if it were a law of causation. The student should read, in illustration of this Aphorism, Mr. Mill's chapter on Empirical Laws. See Mill's Logic, bk. iii. ch. 16.

[32] M. Bouillet draws attention to the fact that 'instantia' is never used in this sense in Classical Latin. But I think he is wrong in saying that it is simply the English word 'instance' (=example) latinised. Instantia (as a translation of ἔνστασις) was a technical term of the schools, and, from the meaning of an 'objection,' which was generally founded on a single case, would easily pass into that which it usually bears in Bacon and in modern works generally. In this Aphorism, it seems to have the meaning of ἔνστασις or objection.

[33] Thus, for instance, till the time of Galileo, it was held that bodies fall

XXVI.

Rationem humanam, qua utimur ad naturam, *anticipationes naturae*[34] (quia res temeraria est et praematura), at illam rationem quae debitis modis elicitur a rebus, *interpretationem naturae*, docendi gratia, vocare consuevimus.

XXVII.

Anticipationes satis firmae sunt ad consensum; quandoquidem, si homines etiam insanirent ad unum modum et conformiter, illi satis bene inter se congruere possent[35].

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to the earth in times inversely proportional to their weights. But some bodies, as, for example, flame, do not fall, but rise. This exception was accounted for by the principle of levity, according to which light bodies tend upwards. The various current divisions of motion, such as natural and violent motion, simple and compound motion, and the like, easily lent themselves to frivolous distinctions of this kind.

The desire to patch up a theory by ingenious devices rather than to review and emend it is well illustrated by the various contrivances of epicycles and eccentrics by which the ancient astronomers endeavoured to retain, in spite of all difficulties, the theory of the circular motion of the heavenly bodies. Another assumption of the ancient astronomy was that the heavenly bodies must be perfect spheres. When Galileo discovered, by means of the telescope, the existence of cavities in the moon, it was asserted, in reply, that they were filled with transparent crystal.

[34] Called in the last paragraph but one of the Preface, anticipationes mentis. See p. 184.

[35] Uniformity of opinion, even if it extend to universal consent, is no evidence of truth.

All men alike might be mad, and there might be no one to observe or point out the fact of their madness. Similar suppositions as to the possibility of the universality of error are constantly started by Descartes, and are resolved, in his philosophy, by the consideration of the veracity of God, who would never have so formed his creatures as to be exposed to the risk of insuperable deception.

Though this Aphorism is stated in an extravagant form, it suggests two very important considerations: (1) the relativity of human knowledge; (2) the possibility of universal error.

With reference to the first, the student may consult, amongst recent writings, Sir W. Hamilton's Essay on the Philosophy of the Unconditioned (published in the 'Discussions'), his Lectures on Metaphysics, Lects. viii, ix, Mill's Examination of Hamilton, chs. 2, 3, 4, and Grote's Plato, ch. 26 (1st ed., vol. ii. pp. 322–363). I shall limit myself to a few remarks, directly suggested by Bacon's supposition. All truth must be relative to ourselves, that is to the special constitution of the human

XXVIII.

Quin longe validiores sunt ad subeundum assensum *anticipationes*, quam *interpretationes;* quia ex paucis collectae, iisque maxime quae familiariter occurrunt, intellectum statim perstringunt, et phantasiam implent; ubi contra, *interpretationes*, ex rebus admodum variis et multum distantibus sparsim collectae, intellectum subito percutere non possunt; ut necesse sit eas, quoad opiniones[36], duras et absonas, fere instar mysteriorum fidei videri.

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faculties. We cannot transcend human consciousness. We cannot do more than observe phenomena and reflect on the observations made. All that we know, we can know only through the medium of our own senses and our own intellect, and hence all knowledge must be *relative* to our own cognitive powers. All that we can say, in the last resort, is that a proposition is true *to us*. As to what may be true or false to other orders of beings, differently constituted, we can have no conception, except so far as we have grounds for supposing that their intelligences and the conditions under which their intelligences work are analogous to our own. As to 'absolute truth,' or 'truth in itself,' the phrase seems to be entirely devoid of meaning, the very word 'truth' implying a percipient or thinking subject as well as an object of perception or thought. Thus, it is quite conceivable that beings with different faculties, or brought up amidst a different set of conditions, might, if they could observe us, suppose us to be all mad after the same fashion, as we, similarly, should suppose them to be.

As regards the second consideration, namely, the possibility of universal error, an important distinction must be drawn. Our *immediate perceptions* (when corrected by comparison with each other and with those of other men) are our ultimate test of truth; if these deceive us, we have no other criterion to guide us. But our *inferences* from these perceptions not only may be, but frequently are, false, and it has sometimes happened, as in the belief that the earth was the centre of the solar system, that all mankind have through several generations been mistaken in the inferences they drew from observed facts. In such cases, the false inference has often, in the first instance, been drawn by one or a few persons, and the rest have accepted it implicitly on their authority. Errors of this kind, however long or universally they may have obtained, need not lead us to despair as to the possibility of attaining truth. Previous errors in reasoning have been detected by the employment of the reasoning process itself, and hence we may fairly suppose that, if there are any questions now on which all men are mistaken, posterity will be able to correct our false inferences, as we have corrected those of our ancestors. The source of our errors itself supplies us with the means of correcting them.

[36] 'So far as concerns the opinions which men have of them,' 'in common

XXIX.

In scientiis, quae in opinionibus et placitis fundatae sunt, bonus est usus *anticipationum* et dialecticae; quando opus est assensum subjugare, non res[37].

XXX.

Non, si omnia omnium aetatum ingenia coierint, et labores contulerint et transmiserint, progressus magnus fieri poterit in scientiis per *anticipationes:* quia errores radicales, et in prima digestione mentis, ab excellentia functionum et remediorum sequentium non curantur.

XXXI.

Frustra magnum expectatur augmentum in scientiis ex superinductione et insitione novorum super vetera; sed instauratio facienda est ab imis fundamentis, nisi libeat perpetuo circumvolvi in orbem, cum exili et quasi contemnendo progressu.

XXXII.

Antiquis auctoribus suus constat honos, atque adeo omnibus; quia non ingeniorum aut facultatum inducitur comparatio, sed viae; nosque non judicis, sed indicis[38] personam sustinemus.

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estimation.' Some of the later editions omit the comma after opiniones, which makes the passage unintelligible.

[37] If the allusion be to the moral and political sciences, the passage must be ironical, as, in Aph. 127, Bacon distinctly states that his method is applicable to all sciences alike, and he particularly specifies logic, ethics, and politics. We may, perhaps, represent his thought somewhat as follows: 'In morals, politics, logic, and sciences of that kind people care so little for truth and so much for disputation and victory, that we may leave them to their own method, till they have changed their ends and point of view. If they wish for truth in these subjects, they must conduct their enquiries according to the new method, duly combining induction with syllogism; but, if they only wish to find arguments for pre-conceived opinions, let them go on in the old fashion.'

[38] 'My object is to shew men the way to truth, not to assume the office of a judge, and pass sentence on other authors.' This is certainly anything but consistent with the severity of the judgments which Bacon presently proceeds to pass on the majority of his predecessors and contemporaries, and specially on Aristotle and the Aristotelians.

The word 'indicis' throws back light on the title of the work, 'Novum

XXXIII.

Nullum (dicendum enim est aperte) recte fieri potest judicium nec de via nostra, nec de iis quae secundum eam inventa sunt, per *anticipationes* (rationem scilicet quae in usu est), quia non postulandum est ut ejus rei judicio stetur, quae ipsa in judicium vocatur.

XXXIV.

Neque etiam tradendi aut explicandi ea, quae adducimus, facilis est ratio; quia, quae in se nova sunt, intelligentur tamen ex analogia veterum [39].

XXXV.

Dixit Borgia de expeditione Gallorum in Italiam, eos venisse cum creta in manibus, ut diversoria notarent, non cum armis, ut perrumperent [40]. Itidem et nostra ratio est, ut doctrina nostra animos idoneos et capaces subintret; confutationum enim nullus est usus, ubi de principiis et ipsis notionibus, atque etiam de formis demonstrationum dissentimus.

XXXVI.

Restat vero nobis modus tradendi unus et simplex, ut

Organum, sive Indicia vera de Interpretatione Naturae.' 'Indicia' in that place may be represented by the phrase 'Indications,' or, as Mr. Kitchin suggests, it may mean 'the opening out of a new way.'

[39] He is calling in question the authority of the court; hence, it is no answer to say that the rules of the court are this and that. He questions the sufficiency of the old logic; hence, it is no answer to say that his methods are not to be found in the old treatises.

[40] 'This Borgia was Alexander VI, and the expedition of the French that under Charles VIII, which over-ran Italy in five months, A. D. 1494.' (Mr. Kitchin's note.) Mr. Ellis quotes the following passage from Nardi: 'Diceva in quei tempi Papa Alessandro sesto che i Francesi havevano corso l' Italia con gli speroni di legno et presola col gesso: dicendo così perchè pigliando essi gli alloggiamenti nelle città loro furieri segnavano le porte delle case col gesso; et cavalcando per loro diporto i gentil' huomini per le terre à sollazzo usavano di portare nelle scarpette à calcagni certi stecchi di legno appuntati, delli quali in vece di speroni si servivano per andare le cavalcature'—*Nardi, Vita di Malespini*, [1597,] p. 18. Mr. Ellis adds that 'In an epitome of the history of Charles the Eighth, which will be found in the "Archives curieuses" of Cember, vol. i. p. 197, and which was apparently written about the beginning of the seventeenth century, the remark ascribed to Alexander the Sixth by Nardi and Bacon is mentioned as a popular saying.

homines ad ipsa particularia et eorum series et ordines adducamus; et ut illi rursus imperent sibi ad tempus abnegationem notionum, et cum rebus ipsis consuescere incipiant.

XXXVII.

Ratio eorum, qui acatalepsiam[41] tenuerunt, et via nostra initiis suis quodammodo consentiunt; exitu immensum

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[41] ἀκαταληψία. The allusion is to the New Academy, the principal representatives of which were Arcesilaus and Carneades, and which mainly flourished in the third and second centuries B.C. For a detailed account of the doctrines of this school, the reader may refer to any of the more recent Histories of Greek Philosophy, such as Ueberweg's or Zeller's. The following brief notice will enable him to understand Bacon's allusions to the school here and elsewhere.

The New Academy, which, as its name imports, professed to be an offshoot of Platonism, may be regarded partly as a development of the sceptical and negative vein which had, from the first, formed part of the Platonic impulse, partly as a strong reaction against the dogmatism of the Stoics. The Stoics had maintained that, besides ἐπιστήμη, demonstrable knowledge, and δόξα, mere opinion, there is a third and intermediate kind of knowledge, quite trustworthy, but not demonstrable. This was called φαντασία καταληπτική or κατάληψις. According to the Stoics, says Tennemann, 'every original representation is the result of impressions produced upon the mind, and hence of sensational perceptions; and is therefore denominated φαντασία, *visum*. Out of these original and sensational impressions, Reason, a superior and directing power (τὸ ἡγεμονικόν), forms our other representations. The *true* are styled by Zeno φαντάσιαι καταληπτικαί, or καταλήψεις, that is, such as are verified by their correspondence with the object to which they refer, are freely assented to, and constitute the foundation of science.' The greater part of our physical and ethical knowledge the Stoics held to be of this intermediate description. In opposition to this theory, the philosophers of the New Academy maintained the doctrine of ἀκαταληψία, that is the impossibility of attaining to such καταλήψεις. According to the ordinary account, which is that adopted by Bacon, they recognised only one certain proposition, namely, that nothing can be known with certainty. It was this dogmatic scepticism ('Nova Academia acatalepsiam dogmatizavit et ex professo tenuit' Aph. 67) which, as is generally supposed, distinguished this school from the Pyrrhonists, Ephectici, or Sceptics proper. The latter endeavoured to maintain an ἐποχή (suspension of judgment) between the affirmation and negation of propositions, saying that it is impossible to know whether we know anything or not. The ἀταραξία (or imperturbableness of mind) which the realisation of this uncertainty produces is the supreme end of philosophy.

Ueberweg, however, questions the accuracy of the popular distinction between the New Academy and the Sceptics. He regards, indeed, the

disjunguntur et opponuntur. Illi enim nihil sciri posse simpliciter asserunt; nos, non multum sciri posse in natura, ea, quae nunc in usu est, via[42]: verum illi exinde authoritatem sensus et intellectus destruunt; nos auxilia iisdem excogitamus et subministramus.

XXXVIII.

Idola[43] et notiones falsae, quae intellectum humanum jam occuparunt atque in eo alte haerent, non solum mentes

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scepticism of the former as the less thorough-going of the two, but not for the reason ordinarily assigned. The philosophers of the New Academy, he supposes, differed, in general, from the Sceptics, in not making ἀταραξία the supreme end of philosophy, and, furthermore, in admitting a theory of probability, which served as a practical guide of life.

This theory of probability recognises three grades. They are derived respectively from (1) φαντασία πιθανή, our first impression of an object; (2) φαντασία πιθανὴ ἅμα καὶ ἀπερίσπαστος, the concurrent testimony of our various impressions; (3) φαντασία ἀπερίσπαστος καὶ διεξωδευμένη, the same concurrent testimony, when thoroughly sifted and examined by the reason. The highest degree of probability takes the place of certainty in other systems. Bacon alludes to the Academic theory of probability in Aph. 67.

[42] It will be noticed that Bacon opposes to the 'nihil sciri posse' of the New Academy 'non multum sciri posse,' that he interpolates 'in natura,' and to 'simpliciter' opposes 'ea, quae nunc in usu est, via.' 'In natura' must not be taken as implying that he thought the old method sufficient for the moral and political sciences. See note on Aphorism 29.

The contrast which Bacon here draws between himself and the philosophers of the New Academy can hardly fail to remind us of the similar contrast which has frequently been drawn between Socrates and the leading Sophists of his time. The method of Socrates began in scepticism, but its object was to re-establish the foundations of knowledge. Similarly, Bacon attempts to destroy the credit of the old method of enquiry, only that he may replace it by a new and surer one. There is a passage in the De Augmentis (bk. i.) in which he says, if not truly, at least finely: 'if we begin with certainties, we shall end in doubts; but if we begin with doubts, and are patient in them, we shall end in certainties.'

[43] Here commences the doctrine of the Idola, which is, perhaps, the best-known, as it is, certainly, one of the most important parts of the Novum Organum. On the meaning of the word 'Idola,' see the first note on Aph. 23. Mr. Ellis draws attention to the various forms in which this doctrine appears in Bacon's different works, but a still more accurate and elaborate account of the changes is given in a note by Mr. Spedding. See Ellis and Spedding's Bacon, vol. i. pp. 89-93, and Note C (by Mr. Spedding), pp. 113-117. To these the reader who may wish for more information on the subject is referred. It is sufficient here to state that the Idols in their earlier form (as they appear in the English

hominum ita obsident, ut veritati aditus difficilis pateat; sed etiam dato et concesso aditu, illa rursus in ipsa instauratione scientiarum occurrent et molesta erunt; nisi homines praemoniti adversus ea se, quantum fieri potest, muniant.

XXXIX.

Quatuor sunt genera *idolorum*, quae mentes humanas

Treatise on the Advancement of Learning) correspond with those of the Tribe, the Cave, and the Market-Place, and that 'the one substantial change which the doctrine of Idols underwent was the admission of the Idola Theatri into the company.' The doctrine occurs in the Valerius Terminus, the Advancement of Learning, the Temporis Partus Masculus, the Partis Secundæ Delineatio, the Distributio Operis, and the De Augmentis, but far the most perfect treatment of it is that in the Novum Organum. On the classification of the Idola into groups I shall say something in a note on the next Aphorism.

It has often been remarked that the doctrine of the Idola was anticipated by Bacon's great namesake, Roger Bacon, who gives a four-fold classification of 'offendicula, quae omnem quemcunque sapientem impediunt.' These are unworthy authority, custom, vulgar opinion, and concealment of ignorance combined with the ostentation of apparent wisdom. Mr. Ellis, however (vol. i. pp. 89, 90), argues very justly that Bacon is not likely to have seen the Opus Majus, which then existed only in manuscript, and, as Mr. Spedding adds, was probably not procurable, and possibly even unknown to him; moreover, the correspondence between the 'idola' and the 'offendicula' is very slight. What probably suggested the idea of the one having been borrowed from the other is the fourfold division which is common to both, but the 'idola,' as we have seen, were, in the original form of the doctrine, enumerated as only three.

Roger Bacon's statement and refutation of the 'offendicula' will be found worked out at great length in the 1st Part of the Opus Majus, and more briefly in the Opus Tertium, cap. 22. Mr. Spedding has quoted the opening words of the former passage. I will append those of the latter, in which there are some interesting variations:

'Quatuor vero sunt causae generales omnium malorum nostrorum, et omnem statum a principio mundi corruperunt, et omnem hominem quantumcunque sapientem (praeter Dominum nostrum Jesum Christum et Beatam Virginem) aliquando extra viam rectam, vel extra ultimam perfectionem coëgerunt declinare. Et sunt fragilis auctoritatis exempla, consuetudinis diuturnitas, et sensus multitudinis imperitae, atque praesumptio humanae mentis, qua quilibet nititur suae imperitiae solatium quaerere, et ea, quae nescit, aut non approbare aut reprobare, et illud modicum quod scit vel aestimat scire, licet nesciat, gaudet imprudenter ostentare.' The rest of the chapter (which will be found in Mr. Brewer's 'Fr. Rogeri Bacon Opera quaedam inedita,' pp. 69–73) is very curious and well worth the attention of the student.

obsident. Iis (docendi gratia) nomina imposuimus; ut primum genus, *idola tribus;* secundum, *idola specus;* tertium, *idola fori*[44]; quartum, *idola theatri*, vocentur[45].

XL.

Excitatio notionum et axiomatum[46] per *inductionem* veram est certe proprium remedium ad *idola* arcenda et summovenda; sed tamen indicatio *idolorum* magni est usus.

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[44] Called in Valerius Terminus Idols of the Palace.

[45] At the beginning of Aphorism 61, there is a trace of an old classification of the Idola into two groups. In introducing the *idola theatri*, Bacon uses the words 'At *idola theatri* innata non sunt, nec occulto insinuata in intellectum; sed ex fabulis,' &c. This points to a classification of the Idola as innate, including the first three classes, and adventitious, including the last class or idola theatri only. And this classification we find adopted in the Distributio Operis. 'Idola autem a quibus occupatur mens, vel Adscititia sunt vel Innata. Adscititia vero immigrarunt in mentes hominum, vel ex philosophorum placitis et sectis vel ex perversis legibus demonstrationum. At Innata inhaerent naturae ipsius intellectus, qui ad errorem longe proclivior esse deprehenditur quam sensus. . . . . Atque priora illa duo Idolorum genera aegre, postrema vero haec nullo modo, evelli possunt. Id tantum relinquitur, ut indicentur, atque ut vis ista mentis insidiatrix notetur et convincatur. . . . . Itaque doctrina ista de expurgatione intellectus ut ipse ad veritatem habilis sit, tribus redargutionibus absolvitur: redargutione philosophiarum, redargutione demonstrationum, et redargutione rationis humanae nativae.' Cp. the Partis Secundae Delineatio (E. and S., vol. iii. p. 548), and see Mr. Spedding's remarks in Note C. to the Preface to the Novum Organum (vol. i. pp. 113–117), where the whole question of the higher classification of the Idola is carefully considered. This higher classification of Adscititia and Innata disappears in the Novum Organum, because, as Mr. Spedding says, when Bacon 'came to describe the several Idols one by one, he became aware both of the logical inconsistency of classing the Idola Fori among the Innata, and of the practical inconvenience of classing them among the Adscititia, and therefore resolved to drop the dichotomy altogether and range them in four co-ordinate classes.'

[46] Bacon regarded Induction as requisite both to give clearness and precision to our notions and to establish true propositions which might serve as the basis of subsequent reasoning, whether inductive or deductive. But, as we have already seen (note to Aph. 14), in order to realise or test the truth or adequacy of a notion, we must form at least one, and frequently a number of judgments. When we employ induction, therefore, 'to elicit a notion,' we necessarily also employ it 'to elicit an axiom,' and hence there is no real distinction between the process of induction or generalisation as applied to notions and as applied to judgments, propositions, or axioms.

Doctrina enim de *idolis* similiter se habet ad *interpretationem naturae*, sicut doctrina de sophisticis elenchis ad dialecticam vulgarem [47].

XLI.

Idola tribus sunt fundata in ipsa natura humana, atque in ipsa tribu seu gente hominum [48]. Falso enim asseritur, sensum humanum [49] esse mensuram rerum; quin contra,

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[47] That is to say, it is Bacon's Doctrine of Fallacies, and its function is to clear the mind of false notions, in order that it may be open to the reception of true ones.

[48] Must we then despair of the possibility of attaining knowledge? We cannot, indeed, transcend the limitations of our own faculties, or know things except in relation to our own bodily and mental constitution; but by comparing our impressions and inferences, one with another, and with those of other men, and, above all, by constantly reviewing and correcting our conceptions by comparison with the facts of Nature, we are able to detect not only the individual peculiarities of our own minds but also the general tendencies to error which are common to mankind at large. The mind, though it is beset with phantoms, has not entirely lost the power of distinguishing between phantoms and realities.

[49] If this is meant to represent the dictum of Protagoras, it does so most inadequately. Protagoras asserted, not that the *senses* uncontrolled by reason, but that *man*, meaning the human faculties generally, was the measure of all things. Πάντων χρημάτων μέτρον ἄνθρωπος, τῶν μὲ ὄντων ὡς ἔστι, τῶν δὲ οὐκ ὄντων ὡς οὐκ ἔστιν. Making due allowance for the relativity of human knowledge, that is, understanding the maxim in the form, 'Man is *to man* the measure of all things,' it seems to be not only true but a truism. And the same may be said of the individual form which the maxim sometimes takes: 'Every man is *to himself* the measure of all things.' In the Theaetetus, however, where the Protagorean dictum is discussed, the theory that Cognition is simply sensible Perception is discussed also, the two enquiries being confounded, and treated as identical. That Protagoras never expressly asserted the latter proposition is almost certain. 'It is not improbable,' says Mr. Grote, 'that the three doctrines' (namely, that man is the measure of all things, that Cognition is sensible Perception, and that Nature consists in a perpetual motion, change, or flux), 'here put together by Plato and subjected to a common scrutiny, may have been sometimes held by the same philosophers. Nevertheless, the language of Plato himself shews us that Protagoras never expressly affirmed knowledge to be sensible Perception: and that the substantial identity between this doctrine, and the different doctrine maintained by Protagoras, is to be regarded as a construction put upon the two by Plato.' The student has already, in a previous note, been referred to Mr. Grote's admirable criticism of the Theaetetus, where the Protagorean dictum, in its various relations, is discussed at great length and with much acuteness.

That the senses alone are competent to furnish knowledge, without any

omnes perceptiones, tam sensus quam mentis, sunt ex analogia hominis, non ex analogia universi [50]. Estque intellectus humanus instar speculi inaequalis ad radios rerum, qui suam naturam naturae rerum immiscet, eamque distorquet et inficit.

XLII.

Idola specus [51] sunt idola hominis individui. Habet enim unusquisque (praeter aberrationes naturae humanae in genere) specum sive cavernam quandam individuam, quae lumen naturae frangit et corrumpit: vel propter naturam

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subsequent operation of the intellect upon the materials supplied by them, seems too crude a theory to have ever been seriously entertained except in the infancy of speculation. It is an entirely different position to assert that the perceptions of the senses are an essential *condition* of knowledge, as is done by Locke, by Kant, and, in fact, by Aristotle, and as appears to be implied throughout by Bacon himself.

[50] The word Analogy is used here, as in Aph. 34, in its more general sense of 'relation,' and not in either its earlier or later technical sense, as employed in Logic. For these, the student may refer to the Editor's works on Deductive Logic, pt. iii. ch. i. n. 2, and on Inductive Logic, ch. 4.

It is the central thought of the Baconian philosophy that we must lay ourselves, as it were, alongside of nature, and study the facts of the external world, instead of commencing with our own thoughts, and projecting these, as it were, on the universe. Man must look without and not within, if he desires to be truly acquainted with the world around him. This idea is perfectly just, providing we recollect that, after all, we can never know things as they are in themselves, but only as they appear to us. The peculiarities of the human mind generally and of the individual mind in particular must, after all our precautions, have their share in determining the form which our knowledge assumes. By what is true, we mean, in the last analysis, that which all men might be brought to acknowledge, if their faculties were in a healthy and vigorous condition, and if they were supplied with all the materials requisite for forming a judgment.

Malebranche (Recherche de la Vérité, livre ii. 2me partie, ch. 2) refers to these words and the next sentence as 'fort judicieuses.'

[51] The metaphor is taken from Plato's Mythe of the Cave, at the opening of the 7th Book of the Republic. But, as is remarked by Sir W. Hamilton (Reid's Works, p. 473, *n.*), the metaphor applies rather to the Idola Tribus than to the class of fallacies here described; for by Plato all mankind, except the few philosophers who have found their way upwards, are regarded as being bound in the same cave, and as mistaking the shadows which pass before them for realities. By Bacon, on the other hand, each man is pictured as dwelling in his own particular cave, and mistaking his individual impressions for those of mankind at large.

cujusque propriam et singularem; vel propter educationem et conversationem cum aliis; vel propter lectionem librorum, et authoritates eorum quos quisque colit et miratur; vel propter differentias impressionum, prout occurrunt in animo praeoccupato et praedisposito, aut in animo aequo et sedato, vel ejusmodi: ut plane spiritus humanus (prout disponitur in hominibus singulis) sit res varia, et omnino perturbata, et quasi fortuita [52]. Unde bene Heraclitus, homines scientias quaerere in minoribus mundis, et non in majore sive communi [53].

XLIII.

Sunt etiam *idola* tanquam ex contractu et societate humani generis ad invicem, quae *idola fori* [54], propter hominum commercium et consortium, appellamus. Homines enim per sermones sociantur; at verba ex captu vulgi imponuntur. Itaque mala et inepta verborum impositio miris modis intellectum obsidet. Neque definitiones aut explicationes, quibus homines docti se munire et vindicare in

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[52] There is an interesting allusion to the Idola Specus in the Cogitata et Visa (E. and S., vol. iii. p. 607): 'Quin certissimum esse, tum generaliter .... tum etiam cuique ex educatione, studiis, et natura sua, vim quandam seductoriam et quasi daemonem familiarem adesse, qui mentem variis et vanis spectris ludat et turbet.' It may be noticed, by the way, that the use of the word 'spectra,' as the equivalent of 'idola,' affords a further proof, if any were wanted, of the sense in which Bacon employed the latter word. Dr. Craik, in proposing to translate 'Idola' as 'spectres,' calls attention to a passage in Cicero's Letters (Ad Fam. xv. 16), in which Cicero observes that Catius, the Epicurean, who had lately died, had given the name of *spectra* to what Epicurus himself, and, before him, Democritus had called *εἴδωλα*.

[53] Mr. Ellis refers to Sextus Empiricus, Adversus Logicos, i. § 133, and ii. § 186 (it should be 286).

[54] The idols of the market-place (or 'palace,' Valerius Terminus) are so called, because words (which are the 'tesserae notionum,' Aph. 14) are the means by which men carry on their ordinary intercourse in the affairs of life. We exchange words as we exchange wares in the market.

In addition to the sections on the fallacies arising from the ambiguous use of terms, to be found in almost any treatise on Logic, the student should read the third book of Locke's Essay, and especially chs. 9, 10, 11, Dugald Stewart's Philosophy of the Human Mind, pt. i. ch. 4, sects. 4, 5 with Note L, and pt. ii. second subdivision, ch. i. (Of Language), sect. 3, Mackintosh's Dissertation on the Progress of Ethical Philosophy, Introduction, and Mr. Mill's Logic, bk. iv. chs. 3–6.

nonnullis consueverunt, rem ullo modo restituunt. Sed verba plane vim faciunt intellectui, et omnia turbant; et homines ad inanes et innumeras controversias et commenta deducunt [55].

XLIV.

Sunt denique *idola*, quae immigrarunt in animos hominum ex diversis dogmatibus philosophiarum, ac etiam ex perversis legibus demonstrationum; quae *idola theatri* [56] nominamus; quia quot philosophiae receptae aut inventae sunt, tot fabulas productas et actas censemus, quae mundos effecerunt fictitios et scenicos. Neque de his quae jam habentur, aut etiam de veteribus philosophiis et sectis tantum loquimur, cum complures aliae ejusmodi fabulae componi et concinnari possint; quandoquidem errorum prorsus diversorum causae sint nihilominus fere communes. Neque rursus de philosophiis universalibus tantum hoc intelligimus, sed etiam de principiis et axiomatibus compluribus scientiarum, quae ex traditione et fide et neglectu invaluerunt. Verum de singulis istis generibus *idolorum*, fusius et distinctius dicendum est, ut intellectui humano cautum sit.

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[55] 'Men take the words they find in use amongst their neighbours; and that they may not seem ignorant what they stand for, use them confidently, without much troubling their heads about a certain fixed meaning; whereby, besides the ease of it, they obtain this advantage, that as in such discourses they seldom are in the right, so they are as seldom to be convinced, that they are in the wrong; it being all one to go about to draw those men out of their mistakes, who have no settled notions, as to dispossess a vagrant of his habitation, who has no settled abode. This I guess to be so; and every one may observe in himself and others, whether it be, or no.'—Locke's Essay, bk. iii. ch. 10. § 4.

[56] In the Temporis Partus Masculus, these are called Idola Scenae. The title is due in either case to the conceit that systems of philosophy and modes of demonstration succeed one another, like plays on the stage.

The twofold source of these Idola, a false philosophy ('ex diversis dogmatibus philosophiarum'), and a false logic ('ex perversis legibus demonstrationum'), should be especially noticed. In the Partis Secundae Delineatio, these subdivisions of the Idola Theatri are ranked as main divisions, and the remaining idola are classified together in a single group as native to the Human Understanding. 'Itaque pars ista, quam destruentem appellamus, tribus redargutionibus absolvitur: Redargutione Philosophiarum; Redargutione Demonstrationum; et Redargutione Rationis Humanae Nativae.' There is the same division in the Distributio Operis. Cp. note on Aph. 39.

XLV.

Intellectus humanus ex proprietate sua[57] facile supponit majorem ordinem et aequalitatem in rebus, quam invenit: et cum multa sint in natura monodica[58], et plena imparitatis, tamen affingit parallela, et correspondentia, et relativa, quae non sunt[59]. Hinc commenta illa, *in coelestibus omnia moveri per circulos perfectos*, lineis spiralibus et draconibus[60] (nisi

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[57] 'Owing to its peculiar nature.' Cp. 'propter naturam propriam' at the beginning of Aph. 51.

[58] That is, monadica. Mr. Ellis observes that, throughout his writings, Bacon has fallen into this error.

[59] This excessive love of system, or tendency to feign parallels and similitudes where none exist, is, in a logical classification of the fallacies, best referred to False Analogy. See Mr. Mill's Logic, bk. v. ch. 5. § 6, and my Inductive Logic, 3rd ed. pp. 324–336. The fanciful application of numbers has always played a great part in fallacious conceptions of this character. See a curious article on the number Seven in the Classical Journal, vol. viii. One of the latest instances of scientific researches being influenced by these speculations is afforded in the case of Huyghens. 'The attention which Huyghens,' says Professor Playfair (Preliminary Dissertation to the Encyclopedia Britannica), 'had paid to the ring of Saturn, led him to the discovery of a satellite of the same planet. His telescopes were not powerful enough to discover more of them than one; he believed, indeed, that there were no more, and that the number of the planets now discovered was complete. The reasoning by which he convinced himself, is a proof how slowly men are cured of their prejudices, even with the best talents and the best information. The planets, primary and secondary, thus made up twelve, the double of six, the first of the perfect numbers. In 1671, however, Cassini discovered another satellite, and afterwards three more, making five in all, which the more perfect telescopes of Dr. Herschell have lately augmented to seven.'

It must be remembered, however, that some of the greatest discoveries in science have originated in the bold use of Analogy. Thus, the whole science of Biology has been revolutionised by following out the analogies between vegetable and animal life, between fossil remains and living organisms, between the structure, habits, and faculties of the lower animals and those of men. The extension of the idea of wave-motion to explain the phenomena of light and sound, and the striking and startling analogies which have often given the first clue to ascertaining the affinities of languages, are other instances which will occur to almost every reader.

[60] The best commentary on this passage is to be found in the Thema Coeli (E. and S., vol. iii. pp. 774–5). 'At manifestum est, planetas non solum impari gradu contendere, sed nec ad idem punctum circuli reverti, verum deflectere versus austrum et boream, cujus deflexionis

nomine tenus) prorsus rejectis. Hinc elementum ignis cum orbe suo introductum est ad constituendum quaternionem cum reliquis tribus, quae subjiciuntur sensui [61]. Etiam elementis (quae vocant) imponitur ad placitum decupla proportio [62] excessus in raritate ad invicem ; et hujusmodi somnia.

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limites sunt tropici; quae deflexio nobis Circulum Obliquum, et Diversam Politatem ejus progenuit; quemadmodum illa celeritatis inaequalitas motum illum Renitentiae. Neque vero hoc etiam commento naturae rerum opus est, cum recipiendo lineas spirales (id quod proxime accedit ad sensum et factum) res transigatur, et ista salventur. Atque (quod caput rei est) spirae istae nil aliud sunt quam defectiones a motu circulari perfecto, cujus planetae sunt impatientes. Prout enim substantiae degenerant puritate, et explicatione, ita degenerant et motus.'

The whole passage from which this extract is taken is interesting, as shewing the immature character of Bacon's astronomical theories.

In a note on this Aphorism, Mr. Ellis says: 'It does not appear in what sense Bacon uses the word "draco." In its ordinary acceptation in old astronomy, it denoted the great circle which is approximately the projection on the sphere of the moon's orbit. The ascending node was called the caput draconis, and the descending the cauda draconis. The same terms were occasionally applied to the nodes of the planetary orbits. It is not improbable that Bacon intended to complain of the rejection of spirals of double curvature, or helices, which, traced on the surface of the sphere, might represent inequalities in latitude. Compare (Nov. Org. ii. 48) what is said of the variations of which the "motus rotationis spontaneus" admits.'

Cp. a passage in the De Augmentis, lib. iii. cap. 4 (E. and S., vol. i. p. 552), where Bacon complains: 'At vix quisquam est, qui inquisivit causas physicas tum de . . . . . tum de motuum obliquatione, vel per spiras se versus tropicos texendo et retexendo, vel per sinuationes quas Dracones vocant.'

[61] The four elements were imagined as having each its natural place, earth being lowest and aether or fire highest. As the orb of fire is above that of air, it is too remote from us to be an object of sense.

[62] This doctrine which prevailed throughout the Schools, though entirely unsupported by evidence and even in spite of the evidence of the senses, owes its origin to a mistaken interpretation of a passage in Aristotle, De Generatione et Corruptione, ii. 6 (p. 333 a. 16–34). The student, on referring to the passage, will find that the 'decupla ratio' is only put hypothetically, for the sake of example: 'οἷον εἰ ἐξ ὕδατος κοτύλης εἶεν ἀέρος δέκα;' 'οἷον εἰ κοτύλη ὕδατος ἴσον δύναται ψύχειν καὶ δέκα ἀέρος.' The order of the elements would, of course, be earth, water, air, fire. A fifth element was added by Aristotle and the Peripatetics, which was regarded as peculiar to the celestial regions and as being the material of which the heavenly bodies were composed. It was called aether. See,

Neque vanitas ista tantum valet in dogmatibus, verum etiam in notionibus simplicibus [63].

XLVI.

Intellectus humanus in iis quae semel placuerunt (aut quia recepta sunt et credita, aut quia delectant), alia etiam omnia trahit ad suffragationem et consensum cum illis [64]: et licet major sit instantiarum vis et copia, quae occurrunt in contrarium; tamen eas aut non observat, aut contemnit, aut distinguendo summovet et rejicit, non sine magno et pernicioso praejudicio, quo prioribus illis syllepsibus [65] authoritas maneat inviolata. Itaque recte respondit ille [66], qui, cum suspensa tabula in templo ei monstraretur eorum qui vota solverant, quod naufragii periculo elapsi sint, atque interrogando premeretur, anne tum quidem Deorum numen agnosceret, quaesivit denuo, *At ubi sunt illi depicti qui post vota nuncupata perierint?* Eadem ratio est fere omnis superstitionis, ut in astrologicis, in somniis, ominibus, nemesibus, et hujusmodi; in quibus homines delectati hujusmodi vanitatibus advertunt eventus, ubi implentur; ast ubi fallunt, licet multo frequentius, tamen negligunt et praetereunt. At longe subtilius serpit

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for instance, Meteorologica, i. 3; De Coelo, i. 3. Cp. note on the words 'ut Gilbertus' in ii. 36 (5).

[63] As, for instance, in the personification of inanimate objects, in anthropomorphic conceptions of God, and the manner in which we attribute to Nature designs and modes of operation analogous to those which we experience amongst men.

[64] This tendency, when we have once formed an opinion, to attach greater importance to affirmative instances, in support of it, than to negative instances, in contradiction of it, is rightly classed by Mr. Mill under the Fallacies of Non-observation of instances. See Mill's Logic, bk. v. ch. 4. § 3, and the Editor's Inductive Logic, 3rd Edition, pp. 250–255. For instances of the Fallacy, the reader is referred to those works.

[65] *σύλληψις*, a conception.

[66] Diagoras, surnamed the Atheist, according to Cicero, De Natura Deorum, iii. 37, where another story to the same purport is told. Diogenes Laertius tells the story, with a slight variation, of Diogenes the Cynic, but adds that it is also told of Diagoras the Melian: *θαυμάζοντος τινὸς τὰ ἐν Σαμοθράκῃ ἀναθήματα, ἔφη, Πολλῷ ἂν εἴη πλείω, εἰ καὶ οἱ μὴ σωθέντες ἀνετίθεσαν. οἱ δὲ, τοῦτο Διαγόρου φασὶ τοῦ Μηλίου.*

hoc malum in philosophiis et scientiis; in quibus quod semel placuit, reliqua (licet multo firmiora et potiora) inficit, et in ordinem redigit. Quinetiam licet abfuerit ea, quam diximus, delectatio et vanitas, is tamen humano intellectui error est proprius et perpetuus, ut magis moveatur et excitetur affirmativis, quam negativis; cum rite et ordine aequum se utrique praebere debeat; quin contra, in omni axiomate vero constituendo, major est vis instantiae negativae [67].

XLVII.

Intellectus humanus illis, quae simul et subito mentem ferire et subire possunt, maxime movetur; a quibus phantasia impleri et inflari consuevit: reliqua vero modo quodam, licet imperceptibili, ita se habere fingit et supponit, quomodo se habent pauca illa quibus mens obsidetur [68]; ad illum vero transcursum ad instantias remotas et heterogeneas [69], per quas

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[67] A single negative instance, if it admit of no explanation, is sufficient to upset a theory, or, at the least, it ought to cause us to suspend our judgment, till we are able either to explain the exception, or to modify the theory in accordance with it, or else to accumulate such an amount of negative evidence as to justify us in rejecting the theory altogether. The negative instance, even where it does not upset a theory, is often peculiarly valuable, in calling attention to a counteracting cause. This, for example, was the case with the deflections of the planet Uranus, which, being inexplicable by known causes, directed the attention of astronomers to the existence of a hitherto undiscovered planet, the planet now called Neptune. An example, on the other hand, of a theory which was upset by a single negative instance, is the old doctrine that bodies fall to the ground in times inversely proportioned to their weights; the experiments of Galileo from the leaning tower of Pisa once and for ever put an end to this delusion.

Bacon may possibly, however, be referring to the method of Exclusions, of which we shall hear so much in the Second Book. On this method, see Introduction, § 9.

[68] The mind is unduly influenced by sudden and simultaneous impressions. A familiar example of this tendency is the unreasoning alarm often produced by railway accidents, accidents in mines, collieries, etc. Such accidents, especially if two or more occur about the same time, 'fill the imagination' and excite an alarm out of all proportion to the actual risk incurred.

[69] Thus, the phenomena of electricity are exhibited on a grand scale in thunder and lightning, which 'strike the mind suddenly and simultaneously,' but the study of these instances alone would never have led to the

axiomata tanquam igne probantur, tardus omnino intellectus est, et inhabilis, nisi hoc illi per duras leges et violentum imperium imponatur.

XLVIII.

Gliscit intellectus humanus, neque consistere aut acquiescere potis est, sed ulterius petit; at frustra [70]. Itaque incogitabile est ut sit aliquid extremum aut extimum mundi, sed semper quasi necessario occurrit ut sit aliquid ulterius [71].

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discovery of those singular and subtle laws of electricity which have been gathered from the 'remote and heterogeneous instances' which could have occurred only to the patient student of nature.

[70] The restless ambition of the intellect is one of the impediments to the attainment of truth. The mind ever desires to penetrate further and further into the nature and causes of things; but in vain. And hence, feeling its helplessness, it falls back upon itself, and supposes the processes of nature to be carried on with the same ends and in the same manner as the works of man.

This Aphorism touches on a number of philosophical difficulties which it would be impossible within the limits of a work like this to discuss fully or satisfactorily. I shall confine myself to a brief statement of my own opinions and to such references as I think likely to be of real use to the student.

[71] The mind is unable to think of the totality of space as finite; for, at whatever point we mentally place ourselves, we cannot but think of some point beyond it. Moreover, if space be finite, it must be bounded by some figure, that is to say, the totality of space must, on this supposition, have some shape or other; but, whether we regard it as spherical, cubical, or of any other shape, there must be some space beyond it in relation to which it is said to be of this or that shape, and in which it is contained. Hence, the proposition that Space (in its totality) is finite or bounded, involves a contradiction in terms; for bounded space must have some space beyond it. But, though we are thus compelled to think of space as infinite, can we conceive infinite space? We certainly cannot realise, imagine, or picture to ourselves infinite space, for it would take an infinity of time to do so. But this circumstance constitutes no valid reason why we should refuse to affirm a proposition, the only alternative of which has been proved to be self-contradictory. We are compelled, therefore, to assert the proposition that Space is not finite, or, in other words, that Space is infinite.

Similarly, we cannot think of time as having had a beginning, for then there would be a time before time; or as about to have an end, for then there would be a time after time. Hence, we are compelled to affirm an infinity of time, as we were before compelled to affirm an infinity of Space.

Neque rursus cogitari potest quomodo aeternitas defluxerit ad hunc diem; cum distinctio illa, quae recipi consuevit, quod sit *infinitum a parte ante, et a parte post,* nullo modo constare possit; quia inde sequeretur, quod sit unum infinitum alio infinito majus, atque ut consumatur infinitum, et vergat ad finitum [72]. Similis est subtilitasde lineis semper divisibilibus,

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Again, though we are as little able to picture to our minds the process of infinitesimal subdivision as that of infinite addition, we are compelled by considerations, similar to those which we have already gone through, to affirm the infinite divisibility of both lines and matter. A line, however small, must have two ends, and so be capable of bisection; an atom must have an upper and an under side, and so be capable of division.

The questions on which I have so briefly touched, and the very conception of infinity itself, have been the occasion of much controversy. The student, who wishes to acquaint himself with the main outlines of these discussions, will do well to read the chapter on 'Infinity' in Locke's Essay (bk. ii. ch. 17); Kant's Kritik der Reinen Vernunft, Transcendentale Dialektik, bk. ii. ch. 2 (Die Antinomie der Reinen Vernunft), where the antinomies or contradictions connected with Cause and God are discussed, as well as those connected with Space, Time, and Matter; Sir W. Hamilton's Lectures on Metaphysics, Lecture 38; Mr. Mill's Examination of Hamilton, ch. 6; and, lastly, as a defence of Sir W. Hamilton and a reply to Mr. Mill, Dr. Mansel's 'Philosophy of the Conditioned.' The student of Kant will derive great assistance from consulting, on this subject, the recent work of Mr. Caird on 'The Philosophy of Kant,' pt. ii. chs. 16, 17. It must be recollected, however, that Mr. Caird's criticisms of Kant, and the extensions which he endeavours to give to his philosophy, are made entirely from the Hegelian stand-point. Much of the difficulty and confusion experienced in dealing with these questions would be avoided, if the student could keep clearly before his mind the fact that the term 'infinite' simply expresses the negation of 'finite.' For 'that alone,' says Locke, 'is infinite, which has no bounds; and that the Idea of Infinity, in which our thoughts can find none.' And again, that is an infinite space or number 'which, in a constant and endless inlarging and progression, the mind can in thought never attain to.' Essay, bk. ii. ch. 17. § 8.

[72] Bacon's criticism is unfortunate and could only arise from his ignorance of mathematics. In reasoning on 'infinities,' it is a first principle that the addition or subtraction of any finite quantity, however large, may, in comparison with infinity, be neglected. $\infty \pm a = \infty$. This formula is entirely independent of the value which we assign to a, provided it be finite.

With regard to the distinction between *infinitum a parte ante* and *infinitum a parte post,* it seems to me that it is not only perfectly legitimate, but that it suggests the only way in which the mind can attempt to picture to itself either infinity of time or infinity of space. We

ex impotentia cogitationis. At majore cum pernicie intervenit haec impotentia mentis in inventione causarum: nam cum maxime universalia in natura positiva [73] esse debeant, quemadmodum inveniuntur, neque sunt revera causabilia; tamen intellectus humanus, nescius acquiescere, adhuc appetit notiora [74]. Tum vero, ad ulteriora tendens, ad proximiora recidit, videlicet ad causas finales [75], quae sunt plane ex natura hominis, potius quam universi: atque ex hoc fonte philosophiam miris modis corruperunt. Est autem aeque imperiti et leviter philosophantis, in maxime universalibus

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mentally take our position at some particular point or moment, usually the present, and try to conceive of an endless regress or an endless progress, as the case may be, from that point or moment. The endless progress is the *infinitum a parte ante*, the endless regress the *infinitum a parte post*.

[73] This passage is obscure, but its meaning appears to be that there are certain great laws of nature, or causes, or, as Bacon would probably have said, 'forms,' in which we ought to acquiesce as ultimate explanations of facts. Such, to take instances from modern science, may, perhaps, be the law of gravity, the law of inertia, and the laws of chemical combination. Now Bacon can hardly mean that these laws, causes, or forms are themselves, as a matter of fact, due to no other cause, but what he does probably mean is that it is in vain for *us* to inquire into their cause; *to us* they are and must be ultimate facts, to be taken for granted, and it is mere idle speculation to try and trace the course of nature beyond them. Cp. with this passage, II. 48 (14), and specially De Augmentis, lib. ix. (E. and S., vol. i. p. 833. l. 10, etc.) See also Introduction, pp. 62, 63.

The word 'positiva' may be translated 'absolute' or 'ultimate.' It seems intended to express the opposite of 'relative' or 'dependent,' that is, relative to or dependent on other causes. These facts are 'to be taken for granted' instead of 'to be explained.'

[74] That is, natura notiora or 'still more general laws.'

[75] For the meaning of the expression 'Final Causes,' the reader may refer to the first foot-note on § 8 of the Introduction, and, for Bacon's criticism of the doctrine, to § 10.

Man projects his own aims and ideas on the Universe, and regards God or Nature as acting in the same way in which he would act himself. Thus, instead of accommodating his thoughts to Nature, he accommodates Nature to his own thoughts. Compare what is said by one of the interlocutors in Galileo's Third Dialogue: 'Great, in my judgment, is the folly of those who would have had God to have made the World more proportional to the narrow capacities of their reason, than to his immense, yea infinite power.' (Sir Thomas Salusbury's Translation, p. 335.)

causam requirere, ac in subordinatis et subalternis[76] causam non desiderare.

XLIX.

Intellectus humanus luminis sicci non est[77]; sed recipit infusionem a voluntate et affectibus, id quod generat *ad quod vult*[78] *scientias:* quod enim mavult homo verum esse, id potius credit[79]. Rejicit itaque difficilia, ob inquirendi impatientiam; sobria, quia coarctant spem; altiora naturae, propter superstitionem[80]; lumen experientiae, propter arrogantiam et fastum, ne videatur mens versari in vilibus et fluxis; paradoxa, propter opinionem vulgi; denique innumeris modis, iisque interdum imperceptibilibus, affectus intellectum imbuit et inficit.

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[76] A logical term, denoting particular propositions in relation to their corresponding universals. Thus, Some X is Y is 'subaltern' to All X is Y.

Mr. Ellis very appropriately quotes Arist. Metaph. iii. 4 (1006 *a.* 6–9). *ἔστι γὰρ ἀπαιδευσία τὸ μὴ γιγνώσκειν τίνων δεῖ ζητεῖν ἀπόδειξιν καὶ τίνων οὐ δεῖ. ὅλως μὲν γὰρ ἁπάντων ἀδύνατον ἀπόδειξιν εἶναι· εἰς ἄπειρον γὰρ ἂν βαδίζοι, ὥστε μηδ' οὕτως εἶναι ἀπόδειξιν.*

[77] Compare the often-quoted maxim of Heraclitus; *αὔη ξηρὴ ψυχὴ σοφωτάτη* or *αὔη ψυχὴ σοφωτάτη καὶ ἀρίστη.* The authorities for these maxims are given in Ritter and Preller's Historia Philosophiae, 2nd ed., p. 26.

[78] Capricious or arbitrary.

[79] Bacon means that the Will and the Affections often exert an influence in warping our judgments. Familiar illustrations are the obstinacy with which men defend opinions to which they have once committed themselves, and the jealousy and repugnance with which they are apt to receive those of their antagonists or rivals. It was a saying of Archbishop Whately, that men are much more anxious to have truth on their side, than to be on the side of truth.

It does not appear to me that Bacon either states or implies that, if the Intellect were freed from the warping influences of the Will and the Affections, its conclusions would be infallibly true. A later school of English moralists, of whom Dr. Samuel Clarke is the principal representative, maintained the doctrine that the Affections are the sole cause of moral aberrations, but to ascribe this or any similar theory to Bacon would involve an anachronism and be inconsistent with the language of the preceding Aphorisms.

Spinoza, in his brief criticism of Bacon's philosophy (see his letter to Oldenburg, Epist. 2, ed. Bruder, vol. ii. pp. 146, 7), makes special reference to this Aphorism.

[80] The thought is that Superstition makes men afraid of enquiring into the 'deep things' of nature, and so determines them to refer to the action or intentions of a First Cause, what is really due to second causes.

L.

At longe maximum impedimentum et aberratio intellectus humani provenit a stupore et incompetentia et fallaciis sensuum [81]; ut ea, quae sensum feriunt, illis, quae sensum immediate non feriunt, licet potioribus, praeponderent. Itaque contemplatio fere desinit cum aspectu; adeo ut rerum invisibilium exigua aut nulla sit observatio. Itaque omnis operatio spirituum [82] in corporibus tangibilibus inclusorum

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[81] It is, perhaps, almost superfluous to remark that, since Bacon's time, the 'dulness, incompetency, and deceptions' of the senses have been, to a great extent, remedied by the discovery of new instruments, by methods of corrections, and by a more careful discrimination between our original perceptions and the subsequent operations of the intellect upon them.

[82] This idea of 'spirits' shut up in bodies, inanimate as well as animate, is of frequent occurrence in the 2nd Book. See, for instance, the 7th and 40th Aphorisms, where some of the statements and speculations are very curious. Immediately borrowed, perhaps, from Paracelsus, or taken generally from the physical philosophy of the day, this doctrine seems to have had a peculiar attraction for Bacon. 'The idea,' says Mr. Ellis (Preface to the Historia Vitae et Mortis, E. and S., vol. ii. p. 94), 'on which Bacon's theory of longevity is founded, namely, that the principle of life resides in a subtle fluid or spirit which permeates the tangible parts of the organisation of plants and animals, seems to be coeval with the first origin of speculative physiology. Bacon was one of those by whom this idea was extended from organised to inorganic bodies: in all substances, according to him, resides a portion of spirit which manifests itself only in its operations, being altogether intangible and without weight. This doctrine appeared to him to be of most certain truth, but he has nowhere stated the grounds of his conviction, nor even indicated the kind of evidence by which the existence of the spiritus is to be established. In living bodies he conceived that two kinds of spirits exist: a crude or mortuary spirit, such as is present in other substances; and the animal or vital spirit, to which the phenomena of life are to be referred. To keep this vital spirit, the wine of life, from oozing away, ought to be the aim of the physician who attempts to increase the number of our few and evil days.'

This physical, or rather metaphysical, theory of a subtle, invisible, and intangible fluid or ether, permeating every material substance, whether animate or inanimate, as well as the language in which we even still speak of 'spirits of wine,' and the like, may be regarded as curious survivals of a primitive, fetichistic era, when men literally believed that every object around them was animated or possessed by a soul or 'spirit' similar to their own, and that this soul or spirit was itself a material, though it might be an invisible, substance. The student will find some most interesting and suggestive remarks on this subject in Mr. Tylor's Primitive Culture, vol. ii. chs. 14, 15.

latet, et homines fugit. Omnis etiam subtilior meta-schematismus[83] in partibus rerum crassiorum (quem vulgo alterationem vocant, cum sit revera latio per minima[84]) latet similiter: et tamen nisi duo ista, quae diximus, explorata fuerint et in lucem producta, nihil magni fieri potest in natura quoad opera. Rursus ipsa natura aëris communis et corporum omnium, quae aërem tenuitate superant (quae plurima sunt), fere incognita est. Sensus enim per se res infirma est, et aberrans: neque organa ad amplificandos sensus aut acuendos multum valent; sed omnis verior interpretatio naturae conficitur per instantias, et experimenta idonea et apposita; ubi sensus de experimento tantum, experimentum de natura et re ipsa judicat.

LI.

Intellectus humanus fertur ad abstracta propter naturam propriam; atque ea, quae fluxa sunt, fingit esse constantia. Melius autem est naturam secare, quam abstrahere[85]; id quod Democriti schola fecit, quae magis penetravit in naturam,

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83 Bacon appears to have adopted a theory of the ultimate constitution of matter, in some respects similar to that of the Atomists (see especially Bk. II. Aph. 8); and hence his partiality for the school of Democritus. He rejected, however, the hypothesis of a vacuum, and it does not appear whether his atoms (or rather particles, as he preferred to call them) differed in material or only in shape and arrangement. Any way, all material objects, he conceived, if only we could penetrate to their ultimate structure or constitution, would be found to consist of a number of small particles, arranged in some definite manner with reference to each other. This arrangement, as it escapes detection, is called *Latens Schematismus*, and any change in it is termed *Meta-Schematismus;* moreover, as the internal process by which such change takes place is unknown to us, it is called *Latens Processus*. (See Bk. ii. Aphs. 6, 7.)

84 It follows from Bacon's theory of the ultimate constitution of matter that any *alteration* (ἀλλοίωσις) in a body is simply a motion amongst the minute particles, a change in their arrangement, 'latio per minima.'

85 It is better to dissect nature by means of analysis, than to form abstract theories about her, which have no foundation in fact or experiment. The work of 'abstraction,' that is of forming abstract or general theories, is, of course, indispensable in the interpretation of nature, but it ought to follow and not precede the work of 'dissection,' that is, the minute examination and interrogation of natural facts. It is on account of their patience or supposed patience in the investigation of nature that the school of Leucippus and Democritus seems to have been preferred by Bacon to the other schools of antiquity.

quam reliquae. Materia potius considerari debet, et ejus schematismi, et meta-schematismi, atque actus purus[86], et lex actus sive motus; formae enim commenta animi humani sunt[87], nisi libeat leges illas actus formas appellare.

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[86] This expression is the scholastic equivalent for the Aristotelian term ἐνέργεια or ἐντελέχεια as opposed to δύναμις, and, as such, may either mean actual, as opposed to possible motion, growth, or development, or actual, as opposed to possible existence. For a δύναμις may either be a possibility of motion (taking that word in its wide, Aristotelian sense), or a possibility of existence. If it be a possibility of existence, the existence itself, when realised, is called an ἐνέργεια or ἐντελέχεια. But, if it be a possibility of motion, we have two cases, according as the motion or process is (1) an end in itself, or (2) results in something beyond itself, an ἔργον τι. Now, in the first case, as, for instance, in walking for the sake of exercise, the actual as opposed to the possible motion may be indifferently called a κίνησις, an ἐνέργεια, and, though hardly with equal propriety, an ἐντελέχεια. In the second case, suppose we take house-building as our instance, we have (α) the mere δύναμις or possibility of house-building, (β) the process itself, οἰκοδομική, (γ) the result, τὸ ἔργον, the house. Here, οἰκοδομική, the process, ought strictly speaking to be called a κίνησις, but it is also called, though with less propriety, an ἐνέργεια or even an ἐντελέχεια; but the end or result, the house itself, can only be said to exist ἐνεργείᾳ or ἐντελεχείᾳ, and the latter expression seems the more appropriate of the two. The terms ἐνέργεια and ἐντελέχεια are often used interchangeably by Aristotle, but, strictly speaking, it would seem that ἐνέργεια (ἐν ἔργῳ) should be appropriated to a motion which is an end in itself, while ἐντελέχεια (ἐν τέλει ἔχειν) ought to be appropriated to the result of a motion or process, or to actual as opposed to possible existence.

On this distinction, the student is specially recommended to read Trendelenburg's first note to De Anima, bk. ii. ch. 1, and to compare the passages in Aristotle's works, where the terms ἐνέργεια and ἐντελέχεια occur. He should notice particularly Metaph. viii. 6 and Eth. vii. 14 (8). Sir Alexander Grant treats of this distinction at some length in one of the Essays appended to his edition of Aristotle's Ethics.

'Actus Purus,' in the present passage, may mean either the process of development by which one material substance passes into another or the final result which follows from the meta-schematismus, that is to say, the change in its structure. Thus, the actus purus might either be the process by which the acorn passes into the oak or iron into rust, or it might be the oak or the rust itself. Conformably to these alternatives, 'lex actus sive motus' may denote either the law governing the process by which the final result is attained, or the law expressing the conditions of the result itself, that is to say, it may denote either a dynamical law or a statical law. I am inclined to think that, in this place, it has the former meaning. Cp. Introduction, Section 8.

[87] He here alludes to the ἰδέαι of Plato, which were conceived as having

LII.

Hujusmodi itaque sunt *idola*, quae vocamus *idola tribus*; quae ortum habent aut ex aequalitate substantiae spiritus humani[88]; aut ex praeoccupatione ejus; aut ab angustiis ejus; aut ab inquieto motu ejus; aut ab infusione affectuum; aut ab incompetentia sensuum; aut ab impressionis modo[89].

LIII.

Idola specus ortum habent ex propria cujusque natura et animi et corporis; atque etiam ex educatione, et consuetudine, et fortuitis. Quod genus, licet sit varium et multiplex, tamen ea proponemus, in quibus maxima cautio est, quaeque plurimum valent ad polluendum intellectum, ne sit purus.

LIV.

Adamant homines scientias et contemplationes particulares; aut quia authores et inventores se earum credunt; aut quia plurimum in illis operae posuerunt, iisque maxime assueverunt. Hujusmodi vero homines, si ad philosophiam et contemplationes universales se contulerint, illas ex prioribus phantasiis detorquent, et corrumpunt; id quod maxime conspicuum cernitur in Aristotele, qui naturalem suam philosophiam logicae suae prorsus mancipavit, ut eam fere inutilem et contentiosam reddiderit[90]. Chemicorum autem genus, ex paucis

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a supra-sensible existence independent of and out of relation to matter. He himself adopts the phrase 'Forms,' but in a peculiar sense of his own, which I have discussed at length in the section of the Introduction just referred to.

[88] By this singular expression he appears to mean that the human mind, being of an uniform substance, is inadequate to represent the inequalities and varieties of nature, and hence that it feigns uniformities and analogies which do not exist. Cp. Aphs. 41 and 45.

[89] These words must refer to the last Aphorism, though the meaning of the reference is not altogether clear. We are 'impressed' with the general and abstract relations of things rather than with their minute structure. The reason at once seizes on or even 'anticipates' the former, while the latter is concealed from the observation of the senses.

[90] Compare the far more vehement attack on Aristotle in Temporis Partus Masculus, cap. 2 (E. and S., vol. iii. pp. 529, 530): 'Itaque citetur Aristoteles, pessimus sophista, inutili subtilitate attonitus, verborum vile ludibrium. Ausus etiam, tum cum forte mens humana ad veritatem

experimentis fornacis, philosophiam constituerunt phantasticam, et ad pauca spectantem[91]: quinetiam Gilbertus, postquam in contemplationibus magnetis se laboriosissime exer-

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aliquam casu quopiam tanquam secunda tempestate delata acquiesceret, injicere durissimas animis compedes, artemque quandam insaniae componere, nosque verbis addicere.' Bacon, however, is not always consistent in his abuse of Aristotle. Sometimes he speaks of him in terms of eulogy, as, for instance, in Aph. 98 and in the following passage of the Redargutio Philosophiarum: 'Itaque hos duos viros, Platonem et Aristotelem, si quis inter maxima mortalium ingenia non numerat aut minus perspicit aut minus aequus est.'

The specific charge against Aristotle that he subordinated his natural philosophy to his logic is undoubtedly founded in part on his partiality for the technical forms and terminology of the syllogism. This circumstance often obscures his argument (as we may see even in the 6th and 7th Books of the Ethics), and also often has a tendency to divert his attention from the arbitrary or questionable character of the principles on which his reasoning proceeds. But under the phrase 'logicae suae,' Bacon probably includes not only 'logic' properly so called, but also the metaphysical distinctions which are of such frequent occurrence in Aristotle's works. Instead of explaining physical phenomena in their true relations or by reference to their true causes, Aristotle frequently, if not generally, deems it sufficient to bring them under his metaphysical distinctions of δύναμις and ἐνέργεια, matter, form, and privation, the four causes, the ten categories, the different kinds of motion, and the like. Of this tendency we have a notable instance in the De Coelo, where we should naturally expect to find a careful account of observed facts with reference to the earth and the heavenly bodies; instead of this account, however, we have interminable discussions on substance, qualities, the various kinds of motion, and other topics of a like metaphysical character. The title of this treatise, however, was not given by Aristotle himself.

[91] Bacon frequently refers to the 'Chemists' or 'Alchemists,' and generally in the same terms. See Aphs. 64 and 73. They are criticised at length, both on their practical and speculative side, in the Redargutio Philosophiarum (E. and S., iii. 575, 576). There is also an interesting notice of them in the De Augmentis, lib. i. (vol. i. p. 457).

In the word 'phantasticam,' he probably has specially in view the speculations of Paracelsus and his school; in the expression 'ad pauca spectantem' the narrow range of objects, such as the transformation of metals and the discovery of the elixir vitae, to which the Chemists or Alchemists of that time confined their attention.

Professor Playfair, in a passage already referred to, says (Encycl. Brit., Prel. Diss.): 'Chemistry in this state might be said to have an Elective Attraction for all that was most absurd and extravagant in the other parts of knowledge.'

cuisset, confinxit statim philosophiam consentaneam rei apud ipsum praepollenti [92].

LV.

Maximum et velut radicale discrimen ingeniorum, quoad philosophiam et scientias, illud est; quod alia ingenia sint fortiora et aptiora ad notandas rerum differentias; alia, ad notandas rerum similitudines [93]. Ingenia enim constantia et acuta figere contemplationes, et morari, et haerere in omni subtilitate differentiarum possunt: ingenia autem sublimia et discursiva etiam tenuissimas et catholicas rerum similitudines et agnoscunt et componunt: utrumque autem ingenium facile labitur in excessum, prensando aut gradus rerum, aut umbras.

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[92] William Gilbert of Colchester (1540–1603), Court-Physician to Queen Elisabeth and author of the celebrated treatise 'De Magnete' published in 1600, was really the founder of the sciences of Electricity and Magnetism. It is, however, indisputable that he regarded his discoveries as admitting of a wider application than was really the case. Thus, he assigned to magnetism some of the phenomena which were afterwards explained by gravitation.

Gilbert (who is repeatedly referred to by Bacon both in the Novum Organum and elsewhere) is mentioned with more respect in Bk. ii. Aph. 35, and with considerable respect in Bk. ii. Aph. 36. Mr. Spedding observes (vol. iii. p. 516): 'Bacon praises him both for his industry and his method; censuring him only for endeavouring to build a universal philosophy upon so narrow a basis.' Thus, in the following quaint passage (from the 'Aditus ad Historiam Gravis et Levis,' E. and S., vol. ii. p. 80), he combines both praise and blame: 'Itaque vires magneticas non inscite introduxit Gilbertus, sed et ipse factus magnes; nimio scilicet plura quam oportet ad illas trahens, et navem aedificans ex scalmo.'

[93] This Aphorism is suggestive of an important psychological fact. The tendency to note resemblances and the tendency to note differences rarely co-exist in an equal degree. Men who have a tendency to note resemblances rather than differences have an imaginative, and frequently a philosophical or poetical turn of mind; men who have a tendency to note differences rather than resemblances have a logical or critical turn of mind. Plato, Shakspeare, and Bacon himself are good instances of the one tendency, Aristotle of the other. As literature accumulates, and thought tends to lose its freshness, men seem to be apt to note differences rather than resemblances. Logic and criticism advance at the expense of poetry and creative philosophy.

Wit has frequently been defined as a faculty of noticing remote resemblances.

The student may compare with this Aphorism a passage in Kant's Kritik der Reinen Vernunft, Anhang zur transcendentalen Dialektik, ed. Hartenstein, vol. iii. p. 442 (Meiklejohn's English Translation, p. 401).

LVI.

Reperiuntur ingenia alia in admirationem antiquitatis [94], alia in amorem et amplexum novitatis effusa; pauca vero ejus temperamenti sunt, ut modum tenere possint, quin aut quae recte posita sunt ab antiquis convellant, aut ea contemnant quae recte afferuntur a novis. Hoc vero magno scientiarum et philosophiae detrimento fit, quum studia potius sint antiquitatis et novitatis, quam judicia: veritas autem non a felicitate temporis alicujus, quae res varia est; sed a lumine naturae et experientiae, quod aeternum est, petenda est. Itaque abneganda sunt ista studia; et videndum, ne intellectus ab illis ad consensum abripiatur.

LVII.

Contemplationes naturae et corporum in simplicitate sua intellectum frangunt et comminuunt; contemplationes vero naturae et corporum in compositione et configuratione sua intellectum stupefaciunt et solvunt [95]. Id optime cernitur in schola Leucippi et Democriti, collata cum reliquis philosophiis. Illa enim ita versatur in particulis rerum, ut fabricas fere negligat; reliquae autem ita fabricas intuentur attonitae, ut ad simplicitatem naturae non penetrent: itaque alternandae sunt contemplationes istae, et vicissim sumendae; ut intellectus reddatur simul penetrans et capax; et evitentur ea, quae diximus, incommoda, atque *idola* ex iis provenientia.

LVIII.

Talis itaque esto prudentia contemplativa in arcendis et summovendis *idolis specus;* quae aut ex praedominantia, aut ex excessu compositionis et divisionis, aut ex studiis erga tempora, aut ex objectis largis et minutis, maxime ortum habent. Generaliter autem pro suspecto habendum unicuique rerum naturam contemplanti quicquid intellectum suum potis-

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[94] See Aph. 84 and the notes on that Aphorism.

[95] These are bold, and somewhat harsh, metaphors. By exclusive attention to the ultimate constitution of nature, in its minute particles, the human intellect is, as it were, broken and frittered away; on the other hand, by the attempt to grasp nature as a whole, it evaporates and is lost in amazement. The precept with which the Aphorism concludes, commending the combination of minute research with general speculations, is of the utmost practical importance, and could hardly be stated in more felicitous language than that in which Bacon has presented it.

simum capit et detinet; tantoque major adhibenda in hujusmodi placitis est cautio, ut intellectus servetur aequus et purus.

LIX.

At *idola fori* omnium molestissima sunt; quae ex foedere verborum et nominum[96] se insinuarunt in intellectum. Credunt enim homines, rationem suam verbis imperare. Sed fit etiam ut verba vim suam super intellectum retorqueant et reflectant; quod philosophiam et scientias reddidit sophisticas et inactivas. Verba autem plerunque ex captu vulgi induntur, atque per lineas vulgari intellectui maxime conspicuas res secant[97]. Quum autem intellectus acutior, aut observatio diligentior, eas lineas transferre velit, ut illae sint magis secundum naturam; verba obstrepunt. Unde fit, ut magnae et solennes disputationes hominum doctorum saepe in controversias circa verba et nomina desinant[98]; a quibus (ex more et prudentia mathematicorum) incipere consultius foret, easque per definitiones in ordinem redigere. Quae tamen definitiones, in naturalibus et materiatis, huic malo mederi non possunt[99]; quoniam et ipsae definitiones ex verbis constant,

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[96] 'From the association of words and names with things.' For references illustrative of the Idola Fori, see notes on Aph. 43.

[97] Cp. Cogitata et Visa, E. and S., vol. iii. p. 599. It sometimes happens that a word only partly expresses the conception which we wish to convey; sometimes it expresses more. There is a similar defect in the distinctions which we attempt to express by two or more contrasted words, such as organic and inorganic, animal and vegetable, rational and irrational, virtue and vice, science and art, and the like. These require constant rectification and definition, in order to make them express exactly what we wish to express and no more. Words, as Bacon says, are inherited from vulgar use, and hence there is often the greatest difficulty in attaching to them any precise, scientific sense, nor, even when this is done, will men always agree to accept or employ them in the sense thus attached to them.

[98] We need only instance such words as idea, sense, cause, reason, substance, etc., in mental philosophy, and cause, force, form, essence, motion, etc., in physical philosophy. The truth of this remark as applied to the questions agitated in morals, politics, and theology will be familiar to every student.

[99] Considerable confusion has arisen in the discussion of questions relating to scientific method from not observing that Definitions are of a very different character and occupy a very different position in the moral and physical sciences, on the one hand, and in the mathematical sciences, on the other. In Mathematics, the inductions by which we gain the most fundamental truths with respect to space and number are

et verba gignunt verba: adeo ut necesse sit ad instantias particulares, earumque series et ordines recurrere; ut mox dicemus, quum ad modum et rationem constituendi notiones et axiomata deventum fuerit.

LX.

Idola, quae per verba intellectui imponuntur, duorum

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peculiarly simple and are performed with such rapidity and, for the most part, at so early an age, that we are hardly conscious of having ever gone through them. Hence, we are able almost at once to construct definitions for the purpose of explaining the most important distinctions which we either find obtruded on our notice, or think it desirable to establish. Moreover, these definitions, when constructed, do not pretend to represent concrete facts but only certain abstract relations of figures and numbers. That such relations exist, if not strictly, at least approximately, no one disputes; they can generally be expressed in a few words, which adequately and exhaustively represent them, and a single technical term is easily invented or appropriated, by means of which the definition can in future be summoned before the mind. About the adequacy or correctness of these definitions there is seldom any difference of opinion, and, even if there be, it does not affect the validity of the subsequent reasoning; for, provided that the same relation be invariably designated by the same name, and that the logical operations be correctly performed, there can be no error in the result. But, when we come to deal with the complex relations of nature and life, it is widely different. Here, Induction occupies a far more important place, and till we have ascertained, distinguished, and classified the more important properties of the objects under investigation, it is in vain to begin the work of Definition. It is only after we have completed the inductive stage of the enquiry that we are in a position to draw up a list of definitions, or, if we venture to do so before, we ought to regard them simply as incomplete and provisional, and hold ourselves in constant readiness to review and correct them. Hence, while the inductive stage of a science is progressive, and therefore incomplete, it is natural that much controversy should turn on the definitions. 'It is necessary,' as Bacon says, 'to be constantly recurring to particular instances,' and we cannot safely reason deductively from the definitions as data, till we have firmly established the inductions on which they rest, and of which they are frequently the expressions, and, indeed, the summaries.

On the nature and place of Definition in Mathematics, the student may refer to Dugald Stewart's Section, entitled 'Of Mathematical Demonstration,' in the Philosophy of the Human Mind (Hamilton's Ed., vol. ii. pp. 113-152), and Mill's Logic, bk. ii. chs. 5, 6; and on the distinction between 'Final and Complete' and 'Incomplete and Provisional' Definitions, to the Editor's chapter on Definitions in his Elements of Deductive Logic.

generum sunt[1]; aut enim sunt rerum nomina, quae non sunt (quemadmodum enim sunt res, quae nomine carent per inobservationem[2]; ita sunt et nomina, quae carent rebus, per suppositionem[3] phantasticam), aut sunt nomina rerum, quae sunt, sed confusa et male terminata, et temere et inaequaliter[4] a rebus abstracta. Prioris generis sunt, fortuna[5], primum mobile[6], planetarum orbes[7], elementum ignis[8], et hujusmodi

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[1] This division of the Idola Fori is important. Sometimes we are deceived by words expressing supposed entities which have no actual existence; sometimes by words which inadequately or erroneously represent actually existing things or properties.

[2] Thus, Naturalists are constantly inventing new names for newly discovered species or varieties. The reader of Aristotle's Ethics will recollect several moral states which Aristotle describes, but designates as nameless. It hardly needs to be observed that, as a science advances, it finds names for these 'nameless' things or qualities.

[3] This word may here be used in its technical sense, for which see Sanderson's Logic, bk. ii. ch. 2.

[4] Cp. Aph. 41, 'Estque intellectus' etc. We might translate inaequaliter as 'partially.' Due care has not been given to the patient examination of all the cases with all their attendant circumstances, and to the abstraction of all disturbing influences in the human mind itself.

[5] Thus, one of the dicta ascribed to Anaxagoras is that Fortune (τύχη) is nothing more than a cause undiscovered by human reasoning, ἄδηλος αἰτία ἀνθρωπίνῳ λογισμῷ. Cp. Juvenal, Sat. x. 365–6:

> 'Nullum numen habes, si sit prudentia: nos te
> Nos facimus, Fortuna, deam coeloque locamus.'

[6] In the ancient systems of Astronomy, the heavens were supposed to consist of a number of hollow and concentric crystalline spheres revolving at different rates of velocity round the earth, and carrying with them the stars and planets. The 'primum mobile' was the outermost sphere of the Universe, in some systems identified with, in others distinguished from, the coelum stellatum or sphere containing the fixed stars. It was regarded as communicating a motion to all the other spheres, apart from their proper or independent motion, and with them revolving round the earth once in twenty-four hours.

[7] These are the spheres in which the planets were supposed to be set, and by which they were supposed to be carried round the earth, each with its own peculiar motion. Mr. Kitchin quotes Milton, Paradise Lost, v. 176:

> 'The fixed stars, fixed in their orb that flies.'

There was supposed to be a similar sphere, external to the others, in which the fixed stars were set. See last note. The reader of Plato's Republic will remember a curious illustration of these crude astronomical theories in the Myth of Er at the end of the tenth Book.

[8] See note 61 on Aph. 45.

commenta, quae a vanis et falsis theoriis ortum habent. Atque hoc genus *idolorum* facilius ejicitur, quia per constantem abnegationem et antiquationem theoriarum exterminari possunt.

At alterum genus perplexum est, et alte haerens; quod ex mala et imperita abstractione excitatur. Exempli gratia, accipiatur aliquod verbum (*humidum,* si placet), et videamus quomodo sibi constent quae per hoc verbum significantur: et invenietur verbum istud, *humidum*, nihil aliud quam nota confusa diversarum actionum, quae nullam constantiam aut reductionem patiuntur. Significat enim et quod circa aliud corpus facile se circumfundit; et quod in se est indeterminabile, nec consistere potest; et quod facile cedit undique; et quod facile se dividit et dispergit; et quod facile se unit et colligit; et quod facile fluit et in motu ponitur; et quod alteri corpori facile adhaeret, idque madefacit; et quod facile reducitur in liquidum, sive colliquatur, cum antea consisteret. Itaque quum ad hujus nominis praedicationem et impositionem ventum sit; si alia accipias, flamma humida est; si alia accipias, aer humidus non est; si alia, pulvis minutus humidus est; si alia, vitrum humidum est: ut facile appareat istam notionem ex aqua tantum, et communibus et vulgaribus liquoribus, absque ulla debita verificatione, temere abstractam esse.

In verbis autem gradus sunt quidam pravitatis et erroris. Minus vitiosum genus est nominum substantiae alicujus, praesertim specierum infimarum, et bene deductarum (nam notio cretae, luti, bona; terrae, mala): vitiosius genus est actionum, ut *generare*, *corrumpere*[8], *alterare:* vitiosissimum qualitatum (exceptis objectis sensus immediatis), ut *gravis*, *levis*, *tenuis*, *densi*, &c.; et tamen in omnibus istis fieri non potest, quin sint aliae notiones aliis paulo meliores, prout in sensum humanum incidit rerum copia[9].

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[8] In Herschel's Discourse on the Study of Natural Philosophy, § 101, note, the student will find a curious example of the kind of verbal jugglery which the ancient reasoners were enabled to carry on by the vague and shifting use of such words as generation, corruption, motion, and the like.

[9] That is, according to the extent of our experience of the objects.

LXI.

At *idola theatri* innata non sunt, nec occulto insinuata in intellectum [10]; sed ex fabulis theoriarum, et perversis legibus demonstrationum, plane indita et recepta. In his autem confutationes tentare et suscipere consentaneum prorsus non est illis, quae a nobis dicta sunt. Quum enim nec de principiis consentiamus, nec de demonstrationibus, tollitur omnis argumentatio. Id vero bono fit fato, ut antiquis suus constet honos [11]. Nihil enim illis detrahitur, quum de via omnino quaestio sit. Claudus enim (ut dicitur) in via antevertit cursorem extra viam. Etiam illud manifesto liquet, currenti extra viam, quo habilior sit et velocior, eo majorem contingere aberrationem.

Nostra vero inveniendi scientias ea est ratio, ut non multum ingeniorum acumini et robori relinquatur; sed quae ingenia et intellectus fere exaequet [12]. Quemadmodum enim ad hoc

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[10] The words 'insinuata in intellectum' apply to the Idola Fori. For the various divisions of the Idola given in the different works of Bacon, see notes on Aphs. 38, 39. We have here a trace of the old division into 'innata,' including the Idola Tribus and Idola Specus, and 'adscititia,' which were co-extensive with the Idola Theatri. Cp. pp. 170, 171. The Idola Fori, as falling under neither division, created a difficulty, and seem here to be regarded as intermediate between the two.

The two divisions of the Idola Theatri, namely, those arising from false systems of philosophy and those arising from perverse laws of demonstration, are sometimes treated by Bacon, as, for instance, in the Distributio Operis, as if they were distinct classes of Idola. Corresponding to them, he proposes to furnish in the Novum Organum a 'Redargutio Philosophiarum' and a 'Redargutio Demonstrationum.' But these 'Redargutiones,' it will be found, are not kept altogether distinct in the Aphorisms which follow. To the remaining 'Idola' corresponds the 'Redargutio Rationis humanae nativae.' Cp. p. 171.

[11] In this and similar passages, which abound throughout the Novum Organum, it is impossible not to detect an air of contemptuous superiority. 'Why should I contend with the ancients for the palm of genius, when it is enough for me that I am on the right road, and they on the wrong one. Let them run as fast as they like. They will only run the further from the truth.'

[12] Commenting on this passage, Macaulay (Essay on Bacon) says: 'This really seems to us as extravagant as it would have been in Lindley Murray to announce that every body who should learn his Grammar would write as good English as Dryden, or in that very able writer, the Archbishop of Dublin, to promise that all the readers of his Logic would reason like Chillingworth, and that all the readers of his Rhetoric would speak like

ut linea recta fiat, aut circulus perfectus describatur, multum est in constantia et exercitatione manus, si fiat ex vi manus propria, sin autem adhibeatur regula, aut circinus, parum aut nihil; omnino similis est nostra ratio. Licet autem confutationum particularium nullus sit usus; de sectis tamen et generibus hujusmodi theoriarum nonnihil dicendum est; atque etiam paulo post de signis exterioribus, quod se male habeant; et postremo de causis tantae infelicitatis et tam diuturni et generalis in errore consensus; ut ad vera minus difficilis sit aditus, et intellectus humanus volentius expurgetur et *idola* dimittat.

LXII.

Idola theatri, sive theoriarum, multa sunt, et multo plura esse possunt, et aliquando fortasse erunt. Nisi enim per multa jam saecula hominum ingenia circa religionem et theologiam occupata fuissent; atque etiam politiae civiles (praesertim monarchiae) ab istiusmodi novitatibus, etiam in contemplationibus, essent aversae; ut cum periculo et detrimento fortunarum suarum in illas homines incumbant, non solum praemio destituti, sed etiam contemptui et invidiae expositi; complures aliae proculdubio philosophiarum et theoriarum sectae, similes illis, quae magna varietate olim apud Graecos

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Burke. That Bacon was altogether mistaken as to this point will now hardly be disputed. His philosophy has flourished during two hundred years, and has produced none of this levelling. The interval between a man of talents and a dunce is as wide as ever; and is never more clearly discernible than when they engage in researches which require the constant use of induction.'

Bacon's promise never has been, and never can be fulfilled. In the Inductive Sciences, there is the same scope for the play of the Imagination, for the work of the creative and inventive faculty, as in Art or Poetry; and there is at least as much occasion for acuteness and rapidity of reasoning as in what are called the exact sciences. The greatest discoveries in science have always been made by men with a keen perception of the analogies of nature, and, consequently, with an aptitude for framing bold, and, at the same time, just hypotheses. The study of scientific method may, and, I believe, does, strengthen and cultivate a man's original powers, but it can never create them or supply their place. It must not be forgotten, however, that, in the work of science, even the humblest intellect can do good service in the way of collecting and arranging materials for subsequent investigation.

I shall recur to this topic in a note on the parallel passage in Aph. 122.

floruerunt, introductae fuissent. Quemadmodum enim super *phaenomena* aetheris plura *themata* coeli confingi possunt; similiter, et multo magis, super *phaenomena* philosophiae fundari possunt et constitui varia dogmata. Atque hujusmodi *theatri* fabulae habent etiam illud, quod in theatro poetarum usu venit; ut narrationes fictae ad scenam narrationibus ex historia veris concinniores sint et elegantiores, et quales quis magis vellet.

In genere autem, in materiam philosophiae sumitur aut multum ex paucis, aut parum ex multis[13]; ut utrinque philosophia super experientiae et naturalis historiae nimis angustam[14] basin fundata sit, atque ex paucioribus, quam par est, pronunciet. Rationale[15] enim genus philosophantium ex experientia arripiunt varia et vulgaria, eaque neque certo comperta, nec diligenter examinata et pensitata; reliqua in meditatione atque ingenii agitatione ponunt.

Est et aliud genus philosophantium, qui in paucis experimentis sedulo et accurate elaborarunt, atque inde philosophias

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[13] 'Multum ex paucis' evidently refers to the Empirical School, as described below and in many other passages, and, consequently, 'parum ex multis' must refer to the Rational or Sophistic School. But its meaning, as referred to this school, is not obvious, the charge against it usually being that it founds propositions of too wide a degree of generality on too slender a basis of fact. Can the phrase mean that the *first* inferences drawn by the Rational School, instead of being true 'axiomata minime generalia' and therefore just covering the facts and no more, are of too vague and general a character, being based on a cursory view of a great number of facts, to be of any service with respect to subsequent inductions? The whole passage might then be paraphrased as follows: 'The Empirical School examines minutely a small number of facts, and bases far too many inferences upon them; the Rational or Sophistic School examines cursorily a large number of facts, and infers from them too few conclusions, while those conclusions are of so vague a character as to be practically useless.' It must be remembered that the 'axiomata minime generalia,' or *first* inferences from the facts, would, according to Bacon's ideal, be very numerous, and would furnish the basis for subsequent inductions of various degrees.

[14] In the first case, the basis of facts is too small; in the second case, the 'axiomata minime generalia,' from which subsequent axioms are to be inferred, are too few.

[15] Called below 'Sophistic.' This division of philosophers trusts too much to mere reasoning, as the next trusts too much to mere experience.

educere et confingere ausi sunt; reliqua miris modis ad ea detorquentes[16].

Est et tertium genus eorum, qui theologiam et traditiones ex fide et veneratione immiscent; inter quos vanitas nonnullorum ad petendas et derivandas scientias a spiritibus scilicet et geniis[17] deflexit; ita ut stirps errorum et *philosophia falsa* genere triplex sit: *sophistica,, empirica, et superstitiosa.*

LXIII.

Primi generis exemplum in Aristotele maxime conspicuum est, qui philosophiam naturalem dialectica sua corrupit[18]: quum mundum ex categoriis effecerit[19]; animae humanae, nobilissimae substantiae, genus ex vocibus secundae intentionis tribuerit[20]; negotium *densi* et *rari*, per quod corpora subeunt

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[16] He here probably alludes specially to Paracelsus.

[17] The allusion here is probably to the Neo-Platonists and Cabbalists, or possibly again to Paracelsus, or, perhaps, to the followers of what Bacon elsewhere calls 'Superstitious Magic.'

[18] See note 90 on Aph. 54.

[19] This may be a specific reference to the opening chapters of the De Coelo, for an account of which the student, who is not familiar with the physical works of Aristotle, may consult Mr. Lewes' Aristotle, ch. 7 (pp. 136, &c.). Or it may refer generally to Aristotle's frequent practice of substituting for the physical explanation of a physical phenomenon its reduction to one of the Categories or to some other arbitrary metaphysical distinction of his own. Or, lastly, it may mean that Aristotle dogmatically attempted to include all forms of existence under one or other of his Categories. Whether, if this last be Bacon's meaning, he has rightly interpreted Aristotle's doctrine of Categories, this is not the place to enquire. The work called the 'Categories' is of doubtful authority, but the distinction itself occurs or is implied in many other works, which are undoubtedly Aristotelian.

There is a parallel passage in the Cogitata et Visa (E. and S., vol. iii. p. 601): 'Hujus autem philosophiae [sc. Philosophiae Naturalis, quam a Graecis accepimus] jam consensu principem Aristotelem, intacta fere ac illibata Natura, in communibus notionibus, atque earum inter se comparatione, collisione, et reductione inutiliter versatum esse. Neque sane quicquam solidi ab eo sperari, qui etiam mundum e categoriis effecerit: Parum enim interesse, utrum quis materiam formam et privationem, an substantiam qualitatem et relationem, principia rerum posuerit.'

[20] This is probably a criticism of a passage in the De Anima, ii. 1 (5), which, however, applies, not to the human soul only, but to life in general: *διὸ ψυχή ἐστιν ἐντελέχεια ἡ πρώτη σώματος φυσικοῦ δυνάμει ζωὴν ἔχοντος.* Without some explanation of this definition, Bacon's criticism is unintel-

majores et minores dimensiones sive spatia, per frigidam distinctionem actus et potentiae transegerit [21]; motum singulis corporibus unicum et proprium, et, si participent ex alio motu, id aliunde moveri, asseruerit [22]: et innumera alia, pro

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ligible, and, bearing in mind the account, given in note 86 on Aph. 51, of the technical terms *ἐνέργεια* and *ἐντελέχεια*, this may easily be supplied.

The lifeless body, as, for instance, the embryo, may be regarded as *capable* of life. It attains its actuality, as soon as it begins to live. Thus, *ψυχή* is the actual manifestation (*ἐντελέχεια*) of that life which every organized body has potentially. But why *ἡ πρώτη*? We must recollect that *δύναμις* and *ἐνέργεια* or *ἐντελέχεια* are purely relative terms; what is a *δύναμις* in one relation may be an *ἐνέργεια* or *ἐντελέχεια* in another. Now *ψυχή*, as we have seen, is the *ἐνέργεια* or *ἐντελέχεια* of *σῶμα*, but *ψυχή*, when once manifested, begins to perform various functions (such as, in the case of man, are perception, thought, &c.). These acts or functions are themselves *ἐνέργειαι*, of which *ψυχή*, in its dormant state, may be regarded as the *δυναμίς*. Hence, while the manifestations of *ψυχή* are, as it were, *δευτέραι ἐνέργειαι*, *ψυχή* itself is a *πρώτη ἐνέργεια*.

That the technical terms of which the definition of *ψυχή* is composed represent 'second intentions' or 'second notions' is plain enough. The student, who is not acquainted with the distinction between 'first' and 'second' notions, should refer to Sir W. Hamilton's Essay on Logic (Discussions, p. 139) or Dr. Mansel's edition of Aldrich's Logic, cap. 1. § 3. div. 8, note. It is possible, however, that Bacon may use the phrase in its later sense, as employed by Aldrich and others, in which case it is equally applicable to the terms of the definition criticised.

[21] Bacon is here probably referring to a passage in the Physics, iv. 5 (6) [p. 213 a. 1–4]: *οὕτω δὲ καὶ ἀὴρ ἔχει πρὸς ὕδωρ· οἷον ὕλη γάρ, τὸ δ' εἶδος τὸ μὲν ὕδωρ ὕλη ἀέρος, ὁ δ' ἀὴρ οἷον ἐνέργειά τις ἐκείνου· τὸ γὰρ ὕδωρ δυνάμει ἀήρ ἐστιν, ὁ δ' ἀὴρ δυνάμει ὕδωρ ἄλλον τρόπον.* Water is regarded as condensed air, and air as rarefied water, and, therefore, either may, in a certain sense, be regarded as being the other potentially. 'Actus' and 'potentia,' of course, correspond respectively with *ἐνέργεια* and *δύναμις*.

Mr. Ellis in his Preface to the Historia Densi et Rari (vol. ii. pp. 236–7) refers to another passage in Aristotle (Categ. ch. 8. p. 10 a. 16–24), where the dense and the rare are explained as due to different modes of the disposition of particles, the particles in dense bodies being near one another, and in rare bodies standing further apart. This is Bacon's own explanation.

[22] This is an allusion to the Scholastic distinction of 'Motus Proprius' and 'Motus Alienus.' All bodies were supposed to have some one motion, and one motion only, proper to them. But, in addition to this motion, they might participate in one or more other motions communicated to them by other bodies. Thus, for instance, the wheel of a watch has a proper motion of one kind only, but, besides this, it may share in the motion of the wearer of the watch. And if the wearer of the watch is sailing on the sea, it participates in no less than three 'extraneous and common' motions, namely the motion of the wearer, the motion of the

arbitrio suo, naturae rerum imposuerit: magis ubique sollicitus[23] quomodo quis respondendo se explicet, et aliquid reddatur in verbis positivum, quam de interna rerum veritate; quod etiam optime se ostendit in comparatione philosophiae ejus ad alias philosophias quae apud Graecos celebrabantur. Habent enim homoiomera Anaxagorae[24], atomi Leucippi et Democriti[25], coelum et terra Parmenidis[26], lis et amicitia Empedoclis[27], resolutio corporum in adiaphoram naturam

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ship, and the motion of the sea. This distinction is often applied by Aristotle to the motions of the heavenly bodies. See, for instance, De Coelo, ii. 13 (p. 293 a. 1, &c.), Phys. viii. 6 (259 b. 28, &c.). Cp. De Coelo, ii. 14 (296 b. 27, &c.). The Aristotelian terms by which Proper Motion is expressed are *οἰκεία* or *ἴδιος φορά*.

[23] This tendency is abundantly exemplified in Aristotle's physical works. He is so anxious to solve every difficulty which presents itself to his mind, that he is seldom content with a bare statement of facts, without starting some theory in explanation of them. As a consequence of this tendency, the facts are often very meagre, and the theories very crude.

[24] *τὰ ὁμοιομερῆ* may denote either aggregates composed of like parts, or these 'like parts' themselves. Anaxagoras maintained that there was an infinity of elements, some of which were homogenous with others, though in the original chaos they were all mixed up in inextricable confusion. Thus, there existed from the first particles of flesh, bone, &c., which, by a process of *σύγκρισις* and *διάκρισις*, have been disentangled from the disorderly mass and fashioned by *νοῦς* or the Supreme Intelligence into flesh, bone, &c., as we now find them in the *κόσμος* or orderly universe. *Πάντα χρήματα ἦν ὁμοῦ· εἶτα νοῦς ἐλθὼν αὐτὰ διεκόσμησε.* See Metaph. i. 3.

For the various philosophical theories mentioned in this paragraph, the student should refer to the passages collected in Ritter and Preller's Historia Philosophîae, as well as to some good History of Philosophy, such as that of Ueberweg, Zeller, or Lewes.

[25] These atoms, unlike the homoiomera of Anaxagoras, had no qualitative difference. They were supposed to differ only in shape (*σχήματι*) as A and N, or arrangement (*τάξει*) as AN and NA, or position (*θέσει*) as Z and N. The *κόσμος* resulted from these atoms through *ἀνάγκη*. See Metaph. i. 4.

[26] Coelum et terra = *πῦρ καὶ γῆ*. It is questionable how far Parmenides intended to express physical conceptions by these words, and how far he intended them to be simply symbolic of the metaphysical contrast of being and non-being. *Τούτων δέ*, says Aristotle, *τὸ μὲν κατὰ τὸ ὄν, τὸ θερμὸν τάττει, θάτερον δὲ κατὰ τὸ μὴ ὄν*. See Metaph. i. 5. The student might here, with advantage, consult Schwegler's History of Philosophy, in addition to Ueberweg and Ritter and Preller.

[27] The well-known four elements of Empedocles, which were generally accepted till a comparatively recent date, were supposed by him to have

ignis et replicatio eorundem ad densum Heracliti[28], aliquid ex philosopho naturali; et rerum naturam, et experientiam, et corpora sapiunt[29]; ubi Aristotelis physica nihil aliud quam dialecticae voces plerunque sonet: quam etiam in metaphysicis sub solenniore nomine[30], et ut magis scilicet realis, non nominalis[31], retractavit. Neque illud quenquam moveat,

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been mixed up at first in chaotic confusion. In order to produce the *κόσμος*, they required to be separated and then re-combined in orderly proportion. The agents in this process were respectively *νεῖκος* and *φιλία*. See Metaph. i. 4.

[28] By fire Heraclitus understood not flame, but a kind of warm, dry ether or refined air, which he identified with soul and with the Divine Spirit. This fire was regarded as undergoing a constant process of evolution (*πάντα ῥεῖ*). By condensation it passes into the other and grosser elements, and then these by rarefaction pass back again into it. Being thus, as it were, the common element or basis, the *ὕλη*, so to speak, of all other existences, it may be regarded as itself 'without distinctive properties,' or 'adiaphora.'

[29] The student who has acquainted himself with the speculations of the last three philosophers whom Bacon cites will hardly be disposed to accord to them this praise. Their conceptions and theories, when divested of the metaphorical language in which they are clothed, are certainly of a metaphysical rather than a physical character. Of Anaxagoras and Democritus the same remark is also, to some extent, true.

[30] This phrase convicts Bacon of a literary error. The books entitled Metaphysics (*τὰ μετὰ τὰ φυσικά*) were so called simply because of the place assigned to them in the collected works of Aristotle, as next to the Physics. The designation of these books has, however, been the origin of the terms Metaphysics, Metaphysical, &c. Aristotle himself calls the science treated of in the 'Metaphysics' *σοφία*, *θεολογική*, or *πρώτη ἐπιστήμη*.

[31] The question whether Aristotle was a realist, a nominalist, or a conceptualist has been frequently debated. Confining ourselves to the issue between the nominalists and realists, the general drift of his writings and a majority of individual passages would favour the alternative that, had the precise question between Nominalism and Realism been raised in his time, he would have adopted the nominalist solution of the question as to the nature of Universals. The most emphatic passage, perhaps, in support of this view is that in the Categories, ch. 5 (p. 2 a. 11 &c.): *Οὐσία δέ ἐστιν ἡ κυριώτατά τε καὶ πρώτως καὶ μάλιστα λεγομένη, ἣ μήτε καθ' ὑποκειμένου τινὸς λέγεται μήτ' ἐν ὑποκειμένῳ τινί ἐστιν, οἷον ὁ τὶς ἄνθρωπος ἢ ὁ τὶς ἵππος. Δεύτεραι δὲ οὐσίαι λέγονται, ἐν οἷς εἴδεσιν αἱ πρώτως οὐσίαι λεγόμεναι ὑπάρχουσι, ταῦτά τε καὶ τὰ τῶν εἰδῶν τούτων γένη, οἷον ὁ τὶς ἄνθρωπος ἐν εἴδει μὲν ὑπάρχει τῷ ἀνθρώπῳ, γένος δὲ τοῦ εἴδους ἐστὶ τὸ ζῷον· δεύτεραι οὖν αὗται λέγονται οὐσίαι, οἷον ὅ τε ἄνθρωπος καὶ τὸ ζῷον. . . . . Τῶν δὲ δευτέρων οὐσιῶν μᾶλλον οὐσία τὸ εἶδος τοῦ γένους· ἔγγιον γὰρ τῆς πρώτης οὐσίας ἐστίν.* Cp. p. 3 b. 10–23. Some suspicion, however, attaches to the genuineness of the two

quod in libris ejus *De animalibus*, et in *Problematibus*, et in aliis suis tractatibus, versatio frequens sit in experimentis. Ille enim prius decreverat, neque experientiam ad constituenda decreta et axiomata rite consuluit; sed postquam pro arbitrio suo decrevisset, experientiam ad sua placita tortam circumducit et captivam; ut hoc etiam nomine magis accusandus sit, quam sectatores ejus moderni (scholasticorum philosophorum genus) qui experientiam omnino deseruerunt [32].

LXIV.

At philosophiae genus *empiricum* placita magis deformia et monstrosa educit, quam *sophisticum* aut rationale genus; quia non in luce notionum vulgarium (quae licet tenuis sit et superficialis, tamen est quodammodo universalis, et ad multa pertinens) sed in paucorum experimentorum angustiis et obscuritate fundatum est. Itaque talis philosophia illis, qui in hujusmodi experimentis quotidie versantur atque ex ipsis phantasiam contaminarunt, probabilis videtur et quasi certa; caeteris, incredibilis et vana. Cujus exemplum notabile est in chemicis, eorumque dogmatibus; alibi autem vix hoc tempore invenitur, nisi forte in philosophia Gilberti [33]. Sed tamen circa hujusmodi philosophias cautio nullo modo praetermittenda erat; quia mente jam praevidemus et auguramur, si quando homines, nostris monitis excitati, ad experientiam se serio contulerint (valere jussis doctrinis sophisticis), tum demum, propter praematuram et praeproperam intellectus festinationem, et saltum sive volatum ad generalia et rerum

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first treatises included in the Organon. Still, independently of the Categories, the balance of evidence is in favour of ranking Aristotle amongst the opponents of the doctrines which were subsequently designated as Realist. It must be remembered, however, that the precise question agitated by the Schoolmen had not been raised in his time. On the subject of Aristotle's opinions in relation to this controversy, it is impossible to enter here at any length, but the student may read with advantage Hauréau's Histoire de la Philosophie Scolastique, ch. 5, and Ueberweg's History of Philosophy, On Aristotle's Metaphysics (Translation, vol. i. pp. 160–1).

[32] On experiment as employed and interpreted by Aristotle, and generally on the reasons of Aristotle's comparative failure in the Physical Sciences, see Introduction, § 11.

[33] On the Chemists or Alchemists and Gilbert, see notes 91, 92 on Aph. 54.

principia, fore ut magnum ab hujusmodi philosophiis periculum immineat; cui malo etiam nunc obviam ire debemus.

LXV.

At corruptio philosophiae ex *superstitione*, et theologia admista, latius omnino patet, et plurimum mali infert, aut in philosophias integras, aut in earum partes. Humanus enim intellectus non minus impressionibus phantasiae est obnoxius, quam impressionibus vulgarium notionum. Pugnax enim genus philosophiae et *sophisticum* illaqueat intellectum: at illud alterum phantasticum, et tumidum, et quasi poeticum, magis blanditur intellectui[34]. Inest enim homini quaedam intellectus ambitio, non minor quam voluntatis; praesertim in ingeniis altis et elevatis.

Hujus autem generis exemplum inter Graecos illucescit, praecipue in Pythagora[35], sed cum *superstitione* magis crassa et onerosa conjunctum; at periculosius et subtilius in Platone[36] atque ejus schola[37]. Invenitur etiam hoc genus mali in

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[34] The one school ensnares the intellect by its specious and fallacious reasonings; the other flatters it by exciting its ambition to penetrate to ultimate causes. Aph. 48 furnishes a good commentary on the words 'blanditur intellectui.'

[35] As in his mystical theories about numbers, his doctrines of metempsychosis, of the harmony of the spheres, &c. On the personal character of Pythagoras, and his position as the founder of a religious brotherhood, there is an excellent chapter in Grote's History of Greece. See pt. ii. ch. 37.

[36] The allusion is, perhaps, specially to the theory of Ideas, and to the use made by Plato of Final Causes and Divine Agency in dialogues such as the Timaeus.

Cp. Cogitata et Visa (E. and S., vol. iii. pp. 601–2): 'Eundem (sc. Platonem) Naturam non minus Theologia quam Aristotelem Dialectica inficere: et si verum dicendum est, tam prope ad poetae, quam illum ad sophistae partes accedere.'

In the Temporis Partus Masculus, the attack on Plato is far more vehement: 'Citetur jam et Plato, cavillator urbanus, tumidus poeta, theologus mente captus,' &c. See E. and S., vol. iii. pp. 530–1.

[37] The reference may be either to the immediate followers of Plato, that is to the Old Academy, or to the Neoplatonists, called in Aph. 96 'secunda schola Platonis.' To the latter, whose philosophy was mainly mystical, it would be peculiarly applicable. To the New Academy, which was properly 'secunda schola Platonis,' it would be inapplicable, as the tendencies of that school were of quite a different character.

partibus philosophiarum reliquarum, introducendo formas abstractas[38], et causas finales, et causas primas[39]; omittendo saepissime medias, et hujusmodi. Huic autem rei summa adhibenda est cautio. Pessima enim res est errorum *apotheosis*[40], et pro peste intellectus habenda est, si vanis accedat veneratio. Huic autem vanitati nonnulli ex modernis[41] summa levitate ita indulserunt, ut in primo capitulo Geneseos, et in libro Job, et aliis Scripturis sacris, philosophiam naturalem fundare conati sint; inter *viva quaerentes mortua*[42]. Tanto-

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[38] Forms abstracted from matter, as opposed to determined in matter. Some of the more extreme realists maintained that forms or essences had an existence independent of and anterior to the individual objects in which they are manifested. This was the doctrine of 'universalia ante rem.'

[39] Bacon always insists on referring physical events to physical causes, and not, as was far more frequently the case in his time than our own, to the immediate action of God. Cp. Advancement of Learning, bk. i. (E. and S., vol. iii. p. 267): 'For certain it is that God worketh nothing in nature but by second causes; and if they would have it otherwise believed, it is mere imposture, as it were in favour towards God; and nothing else but to offer to the author of truth the unclean sacrifice of a lie.' In the corresponding passage of the De Augmentis, bk. i. (E. and S., vol. i. p. 436), he speaks rather more cautiously: 'Liquet enim Deum nihil operari ordinario in natura nisi per secundas causas,' &c.

[40] Cp. the Temporis Partus Masculus (E. and S., vol. iii. p. 531), where, in addressing Plato, he says: 'Deinde etiam tu scelere haud minore stultitiae apotheosin introduxisti, et vilissimas cogitationes religione munire ausus es.'

[41] Bacon is probably alluding more especially to his contemporary Dr. Robert Fludd (b. 1574, d. 1637), whose writings present a strange jumble of physics, theology, and mysticism. He was the author of many works on science and medicine, but the one to which Bacon probably here alludes is that entitled: 'Utriusque Cosmi metaphysica, physica atque technica historia,' published in 1617. A second volume of this work appeared in 1619, with the quaint title: 'Tomus Secundus De Supernaturali, Naturali, Praeternaturali, et Contranaturali Microcosmi historia.' Any one acquainted with the history of Geology will recall many striking illustrations, some of them comparatively recent, of Bacon's criticism.

[42] See Luke xxiv. 5. Cp. De Augmentis, lib. ix. (E. and S., vol. i. p. 835): 'At in interpretandi modo Soluto duo interveniunt excessus: alter ejusmodi praesupponit in Scripturis perfectionem, ut etiam omnis philosophia ex earum fontibus peti debeat; ac si philosophia alia quaevis, res profana esset et ethnica. Haec intemperies in schola Paracelsi praecipue, necnon apud alios invaluit: initia autem ejus a Rabbinis et Cabalistis defluxerunt.

que magis haec vanitas inhibenda venit, et coercenda, quia ex divinorum et humanorum malesana admistione non solum educitur philosophia phantastica, sed etiam religio haeretica. Itaque salutare admodum est, si mente sobria fidei tantum dentur quae fidei sunt.

LXVI.

Et de malis authoritatibus philosophiarum, quae aut in *vulgaribus notionibus*, aut in *paucis experimentis*, aut in *superstitione* fundatae sunt, jam dictum est. Dicendum porro est et de vitiosa materia contemplationum [43], praesertim in philosophia naturali. Inficitur autem intellectus humanus ex intuitu eorum quae in artibus mechanicis fiunt, in quibus corpora per compositiones aut separationes ut plurimum alterantur; ut cogitet simile quiddam etiam in natura rerum universali fieri [44]. Unde fluxit commentum illud elementorum,

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Verum istiusmodi homines non id assequuntur quod volunt; neque enim honorem, ut putant, Scripturis deferunt; sed easdem potius deprimunt et polluunt. Coelum enim materiatum et terram qui in Verbo Dei quaesiverit (de quo dictum est; *Coelum et Terra pertransibunt, Verbum autem meum non pertransibit*), is sane transitoria inter aeterna temere persequitur. Quemadmodum enim Theologiam in Philosophia quaerere, perinde est ac si vivos quaeras inter mortuos; ita e contra Philosophiam in Theologia quaerere, non aliud est quam mortuos quaerere inter vivos.'

We must recollect that sentiments of this kind, which with us have become common-places, were in Bacon's time novel and almost paradoxical. The attempt to find a solution of scientific questions in the Scriptures, and the practice of opposing Scriptural authority to scientific conclusions, have hardly even yet become obsolete; but, in Bacon's time, they were the rule, while with us they are the exception.

[43] He now passes from erroneous modes of philosophising, sophistic, empiric, and superstitious, to fictitious or ill-selected objects of investigation, such as typical forms, specific virtues, occult properties, and the like.

[44] This error consists in supposing that all the processes of nature may be explained by the idea of Mechanical Composition. On the confusion between chemical and mechanical composition, the student may refer to Mill's Logic, bk. iii. ch. 6. Hence, says Bacon, has arisen the fiction of elementary qualities. These were enumerated by the Peripatetics, following Aristotle, as hot and cold, dry and moist. The four elements were supposed to result from combinations of these elementary qualities, taken two and two together. Thus fire is constituted by the combination of hot and dry; water by that of cold and moist, and so on. Out of the four

atque illorum concursu[44], ad constituenda corpora naturalia Rursus, quum homo naturae libertatem contemplatur, incidit in species rerum, animalium, plantarum, mineralium; unde facile in eam labitur cogitationem, ut existimet esse in natura quasdam formas rerum primarias, quas natura educere molitur: atque reliquam varietatem ex impedimentis et aberrationibus naturae in opere suo conficiendo, aut ex diversarum specierum conflictu, et transplantatione alterius in alteram, provenire[45]. Atque prima cogitatio qualitates primas elementares[46], secunda proprietates occultas et virtutes specificas[47] nobis peperit; quarum utraque pertinet ad inania

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elements themselves, are composed the various natural bodies, as we actually find them.

Bouillet notices that, in the Thema Coeli (E. and S., vol. iii. p. 777), hardness and softness are counted amongst the 'elementary qualities.'

[44] We must obviously read either concursus, or deque instead of atque.

[45] This is an excellent statement of the hypothesis by which the Realists attempted to account at once for the permanence and variety in the forms of animal and vegetable life. The 'primary forms' or types were, according to the strictest and most consistent school of Realists, supposed to have existed prior to any of the individual objects in which they are embodied. These types 'natura educere molitur.'

It is, perhaps, superfluous to remark that, since the publication of Mr. Darwin's work on the 'Origin of Species,' the questions glanced at in this paragraph have assumed, even amongst those who do not accept Mr. Darwin's hypotheses, an altogether different form and received an altogether different solution from that which was formerly current.

[46] See last note but one. All the remaining qualities of bodies were called secondary. This distinction is, of course, quite different from that of the primary and secondary qualities of bodies, as stated by Descartes, Locke, and subsequent writers. See Hamilton on Reid, pp. 836–7.

[47] Cp. Newton's Optics, bk. iii. (Works, Ed. Horsley, vol. iv. p. 261), where, speaking of the Principles of Motion, he says: 'And the Aristotelians gave the name of Occult qualities not to manifest qualities, but to such qualities only as they supposed to lie hid in bodies, and to be the unknown causes of manifest effects: such as would be the causes of gravity, and of Magnetic and Electric attractions, and of fermentations, if we should suppose that these forces, or actions, arose from qualities unknown to us, and incapable of being discovered and made manifest. Such Occult qualities put a stop to the improvement of Natural Philosophy, and therefore of late years have been rejected. To tell us, that every species of things is endowed with an occult specific quality, by which it acts and produces manifest effects, is to tell us nothing: but to derive two or three general principles of motion from phaenomena, and afterwards to tell us how the properties and actions of all corporeal things follow

contemplationum compendia, in quibus acquiescit animus et a solidioribus avertitur. At medici in secundis rerum qualitatibus et operationibus, attrahendi, repellendi, attenuandi, inspissandi [48], dilatandi, astringendi, discutiendi, maturandi, et hujusmodi, operam praestant meliorem; atque, nisi ex illis duobus (quae dixi) compendiis (qualitatibus scilicet elementaribus, et virtutibus specificis) illa altera (quae recte notata sunt) corrumperent, reducendo illa ad primas qualitates earumque mixturas subtiles et incommensurabiles, aut ea non producendo cum majore et diligentiore observatione ad qualitates tertias et quartas, sed contemplationem intempestive abrumpendo, illi multo melius profecissent. Neque hujusmodi virtutes (non dico eaedem, sed similes) in humani corporis medicinis tantum exquirendae sunt; sed etiam in caeterorum corporum naturalium mutationibus.

Sed multo adhuc majore cum malo fit, quod quiescentia rerum principia, *ex quibus* [49]; et non moventia, *per quae* res fiunt, contemplentur et inquirant. Illa enim ad sermones,

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from those manifest principles, would be a very great step in philosophy, though the causes of those principles were not yet discovered: and therefore I scruple not to propose the principles of motion above-mentioned, they being of very general extent, and leave their causes to be found out.'

The conceptions of 'occult properties' and 'specific virtues' belong to that stage of speculation in which men believed that the properties of objects were distinct entities, separable, as it were, from the objects themselves, and dwelling in them. In a still prior stage of speculation, these properties had been personified and regarded as divine. See Mommsen's History of Rome, bk. i. ch. 12 (Dickson's Translation, vol. i. pp. 171–3), and Tylor's Primitive Culture, ch. 15 (vol. ii. first ed. pp. 220–223, second ed. pp. 242–246).

[48] 'Inspissandi stands over against Attenuandi; its meaning being "condensation." It does not occur in [classical] Latin writers.' (Mr. Kitchin's note.)

[49] The third error arises from concentrating our attention too exclusively on the 'principia ex quibus,' to the neglect of the 'principia per quae,' that is, on the material to the neglect of the efficient cause. For practical purposes, it is far more important to ask how a thing may be produced, than what it is. Bacon's frequent remarks on the Latens Schematismus and on the Atomistic Philosophy shew, however, the importance which he attached to the enquiry into the Material Cause, and in the De Augmentis (lib. iii. cap. 4), he specifies the Material and Efficient Causes as the appropriate objects of Physics, the Final and Formal Causes being relegated to Metaphysics.

ista ad opera spectant. Neque enim vulgares illae differentiae motus, quae in naturali philosophia recepta notantur, *generationis, corruptionis, augmentationis, diminutionis, alterationis*, et *lationis* [50], ullius sunt pretii. Quippe hoc sibi volunt; si corpus, alias non mutatum, loco tamen moveatur, hoc *lationem* esse; si, manente et loco et specie, qualitate mutetur, hoc *alterationem* esse; si vero ex illa mutatione moles ipsa et quantitas corporis non eadem maneat, hoc *augmentationis* et *diminutionis* motum esse; si eatenus mutentur, ut speciem ipsam et substantiam mutent, et in alia migrent, hoc *generationem* et *corruptionem* esse. At ista mere popularia sunt, et nullo modo in naturam penetrant; suntque mensurae et periodi tantum, non species motus. Innuunt enim illud, *hucusque*, et non *quomodo*, vel *ex quo fonte*. Neque enim de corporum appetitu, aut de partium eorum processu, aliquid significant; sed tantum quum motus ille rem aliter ac prius, crasso modo, sensui exhibeat, inde divisionem suam auspicantur. Etiam quum de causis motuum aliquid significare volunt, atque divisionem ex illis instituere, differentiam motus naturalis et violenti [51], maxima cum socordia, introducunt; quae et ipsa omnino ex notione vulgari est; cum omnis motus violentus etiam naturalis revera sit, scilicet cum externum efficiens naturam alio modo in opere ponet quam quo prius.

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[50] See Categories, ch. 14 (p. 15 a. 13, 14): Κινήσεως δέ ἐστιν εἴδη ἕξ, γένεσις, φθορά, αὔξησις, μείωσις, ἀλλοίωσις, ἡ κατὰ τόπον μεταβολή. In the Physics, bk. v. ch. 1 (p. 225 a. 25–34), γένεσις and φθορά are excluded from the divisions of motion. The only one of these divisions which we call motion is ἡ κατὰ τόπον μεταβολή or latio, or, as it is sometimes called by Aristotle, φορά. The others are motions amongst the parts of the body, not motion of the body as a whole.

[51] Cp. Bk. ii. Aph. 48 (3), where the reader will see how far Bacon himself was from comprehending the true Laws of Motion. The distinction of Natural and Violent Motion will be found, amongst many other places, in Phys. iv. 8, v. 6, and viii. 4. All bodies in motion, Aristotle conceived, naturally tend to rest, heavy bodies, as earth, tending downwards, and light bodies, as fire, tending upwards. This is Natural Motion. But, if a body be in any way diverted from this natural motion, as, for instance, when we throw a stone upwards, it is said to be moved violently or unnaturally (βίᾳ or παρὰ φύσιν). Bodies, while moving in accordance with nature, are said to seek their own place. This distinction of Natural and Violent Motion is again criticised in ii. 36 (6) and 48 (7).

At hisce omissis; si quis (exempli gratia) observaverit, inesse corporibus appetitum contactus [52] ad invicem, ut non patiantur unitatem naturae prorsus dirimi aut abscindi, ut vacuum detur: aut si quis dicat, inesse corporibus appetitum se recipiendi in naturalem suam dimensionem vel tensuram [53], ut, si ultra eam aut citra eam comprimantur aut distrahantur, statim in veterem sphaeram et exporrectionem suam se recuperare et remittere moliantur: aut si quis dicat, inesse corporibus appetitum congregationis ad massas connaturalium suorum, densorum videlicet versus orbem terrae, tenuiorum et rariorum versus ambitum coeli [54]: haec et hujusmodi vere physica sunt genera motuum. At illa altera plane logica sunt et scholastica, ut ex hac collatione eorum manifesto liquet.

Neque minus etiam malum est, quod in philosophiis et contemplationibus suis, in principiis rerum atque ultimatibus naturae investigandis et tractandis, opera insumatur; cum omnis utilitas et facultas operandi in mediis consistat [55].

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[52] This, as Mr. Kitchin says, embodies 'a dim notion of attraction, based on the old opinion as to Nature's abhorrence of a Vacuum.' It is, perhaps, needless to add that the fact of attraction of adhesion (for it is to this that Bacon appears to allude) has been established by subsequent researches, whereas the theory that 'Nature abhors a vacuum' has long ago been exploded. On the latter theory and the experiments which led to its final abandonment, see Herschel's Discourse on the Study of Natural Philosophy, §§ 244–246.

[53] This is obviously a description of the phenomenon of Elasticity.

[54] Cp. ii. 48 (7). Bacon is peculiarly unfortunate in his illustration of the notion of Affinity. The aggregation of bodies or rather particles which are chemically homogeneous into large masses is an undoubted fact, but the affinity of heavy things for the earth and of light things for the sky is a mere fancy, implying the now exploded theory of absolute levity. Heavy and light are, of course, only relative terms, and are better expressed by more or less heavy; all bodies possessing weight, however various it may be in amount. On the supposed substance Phlogiston, which was regarded as essentially light, and the reasoning by which its existence has been disproved, see Herschel's Discourse on the Study of Natural Philosophy, § 336. The notion of absolute levity is connected with that of natural motion, discussed under note 51 on this Aphorism.

[55] The fifth and last error under this head consists in the neglect of intermediate axioms, and the excessive attention paid to the principles of things and the ultimate constitution of nature. Cp. Aph. 104, where this idea is still further expanded. It is undoubtedly true that the practical

Hinc fit, ut abstrahere naturam homines non desinant, donec ad materiam potentialem et informem[56] ventum fuerit; nec rursus secare naturam desinant, donec perventum fuerit ad atomum; quae, etiamsi vera essent, tamen ad juvandas hominum fortunas parum possunt[57].

LXVII.

Danda est etiam cautio intellectui de intemperantiis philosophiarum, quoad assensum praebendum aut cohibendum; quia hujusmodi intemperantiae videntur *idola* figere, et quodammodo perpetuare, ne detur aditus ad ea summovenda.

Duplex autem est excessus: alter eorum, qui facile *pronunciant*, et scientias reddunt positivas et magistrales; alter eorum, qui *acatalepsiam* introduxerunt, et inquisitionem vagam sine termino; quorum primus intellectum deprimit, alter enervat. Nam Aristotelis philosophia, postquam caeteras philosophias (more Ottomanorum erga fratres suos) pugnacibus confutationibus contrucidasset[58], de singulis pronun-

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applications of science are usually deduced from axiomata media rather than from the highest generalisations, but these last are, at the same time, indispensable to the complete constitution of a science. To be of scientific value, however, they must not be mere intellectual abstractions, but duly based on facts and capable of verification, 'talia scilicet, quae non abstracta sint, sed per haec media vere limitantur.'

[56] The ὕλη of the Greek Philosophers.

[57] This remark is hardly consistent with Bacon's frequent praise of Democritus, or with the importance which he attaches to the discovery of the latens processus and the latens schematismus (see especially Bk. ii. Aphs. 6–9).

From a full consideration of the various passages in which he alludes to, or discusses the question, I am of opinion that Bacon, while adopting the atomic theory as to the ultimate constitution of matter, rejected the vacuum by which the minute particles were supposed to be separated. Hence the varying terms in which he speaks of Democritus. See my notes on ii. 8 ad init., ii. 48 (2), and ii. 48 (conclusion).

[58] Cp. Campanella, Metaph. lib. i. Prooemium: 'Ambitione Aristoteles volens videri omnium sapientissimus, dogmata antiquorum falsificat, impugnat, et torquet, et furatur, contraria dicens et sentiens, ut inquit Lactantius in eum, et Patres multi, et D. Thom. 4 de Reg. Princ. 4, et quam ipse ignorat veritatem, proponit tanquam sciens, tegendo suam ignorantiam argutiis et eorum contemptu.' Several other passages to the same effect from writers anterior to or contemporary with Bacon are quoted in the Introduction, § 12.

ciavit; et ipse rursus quaestiones ex arbitrio suo subornat, deinde conficit; ut omnia certa sint et decreta [59]: quod etiam apud successiones suas valet et in usu est.

At Platonis schola *acatalepsiam* introduxit [60], primo tanquam

[59] Bacon here undoubtedly exaggerates Aristotle's tendency to dogmatism. The student of Aristotle will recall several passages where, after stating different solutions of a question, the author leaves his own opinion doubtful. This occasional uncertainty as to the precise character of his own conclusions is, in fact, one of the main sources of difficulty to those who are beginning the study of Aristotle's works.

[60] On the doctrines of the New Academy, see note 41 on Aph. 37. The process by which the dogmatism of the early Platonists passed into the scepticism of the New Academy would form an interesting enquiry in the history of philosophy. In the first place, it may be observed that there was from the beginning a well-marked negative vein in the philosophy of Socrates and Plato. This, which was connected with their dialectical method and the determination to examine all sides of a question, even if the examination led to no further result, is well brought out by Mr. Grote both in the chapter on Socrates in his History of Greece and in the 6th chapter of his work on Plato. When men found that a question might be discussed with so much ability on all sides, and that often without attaining any positive result, it was not unnatural to conclude that there was no result to be attained. Then, the εἰρωνεία, or affectation of ignorance, which was so marked a feature in the conversation of Socrates, and which is so carefully and frequently depicted in the dialogues of Plato, must have had a similar effect in leading men to despair of the possibility of knowledge. To this characteristic Bacon here alludes in the words, 'primo tanquam per jocum et ironiam,' &c. The object of Socrates, however, was not to induce scepticism, but to purify the mind from all pre-conceived opinions, in order to prepare it for the more impartial investigation of truth. Lastly, Plato had spared no pains in demolishing the general belief in the trustworthiness and accuracy of sense-knowledge, in order to rear on its ruins his theory of Ideas. This doctrine, in its turn, had been severely criticised, and, in the opinion of many, refuted by Aristotle. Hence, we cannot be surprised if to some there seemed to be no way out of the dialectical puzzles and subtleties by which the question of the reality of knowledge was perplexed. The solution of these difficulties offered by the philosophers of the New Academy, in their ascending grades of probability, has been already given in note 41 on Aph. 37.

In the De Augmentis, lib. i. (E. and S., vol. i. p. 462), Bacon couples the name of Socrates with that of the [New] Academy: 'Non negaverim in summariis libellis ad praxim destinatis hanc formulam scribendi retineri posse, verum in justis tractatibus de scientiis utrumque extremum vitandum censeo, tam Velleii Epicurei, nil tam metuentis quam ne dubitare de re aliqua videretur, quam Socratis et Academiae omnia in dubio relinquentium.' The allusion to Velleius, the Epicurean, is borrowed from Cicero,

per jocum et ironiam, in odium veterum sophistarum[61], Protagorae, Hippiae, et reliquorum, qui nihil tam verebantur, quam ne dubitare de re aliqua viderentur. At nova academia *acatalepsiam* dogmatizavit, et ex professo tenuit: quae licet honestior ratio sit, quam *pronunciandi* licentia, quum ipsi pro se dicant se minime confundere inquisitionem, ut Pyrrho fecit et Ephectici, sed habere quod sequantur ut probabile[62], licet non habeant quod teneant ut verum; tamen postquam animus humanus de veritate invenienda semel desperaverit, omnino omnia fiunt languidiora: ex quo fit, ut deflectant homines potius ad amoenas disputationes et discursus, et rerum quasdam peragrationes, quam in severitate inquisitionis se sustineant. Verum, quod a principio diximus et perpetuo agimus, sensui et intellectui humano eorumque infirmitati authoritas non est deroganda, sed auxilia praebenda.

LXVIII.

Atque de *idolorum* singulis generibus, eorumque apparatu jam diximus; quae omnia constanti et solenni decreto sunt abneganda et renuncianda, et intellectus ab iis omnino liberandus est et expurgandus; ut non alius fere sit aditus ad regnum hominis, quod fundatur in scientiis, quam ad regnum coelorum, *in quod, nisi sub persona infantis, intrare non datur.*

De Natura Deorum, lib. i. cap. 8: 'Tum Velleius, fidenter sane, ut solent isti, nihil tam verens, quam ne dubitare aliqua de re videretur: tanquam modo ex deorum concilio, et ex Epicuri intermundiis descendisset.' In this Aphorism there is no allusion to Velleius by name, but a portion of the passage in the De Natura Deorum is incorporated in the text.

[61] The positive and dogmatic character of the old Sophists is well illustrated in the 1st book of Plato's Republic, in the person of Thrasymachus, who, however, must be regarded as a caricature. The English reader may be referred, on the subject of the Sophists, to Mr. Lewes' History of Philosophy, Grote's chapter on the Sophists in his History of Greece and his work on Plato throughout, Sir Alexander Grant's second Essay prefixed to his edition of Aristotle's Ethics, and Mr. Henry Sidgwick's papers in the Journal of Philology.

[62] For these grades of probability, see note 41 on Aph. 37. On the distinctions, real or supposed, between the doctrines of the New Academy and the Sceptics proper, see the same note. The school of Pyrrho (often called Pyrrhonists as well as Sceptics) was prior to that of the New Academy, Pyrrho himself being contemporary with Alexander the Great, but it was revived at a much later period by Ænesidemus and his successors, among whom was Sextus Empiricus.

LXIX.

At pravae demonstrationes, *idolorum* veluti munitiones quaedam sunt et praesidia [63]; eaeque, quas in dialecticis habemus, id fere agunt, ut mundum plane cogitationibus humanis, cogitationes autem verbis addicant et mancipent [64]. Demonstrationes vero potentia quadam [65] philosophiae ipsae sunt et scientiae. Quales enim eae sunt, ac prout rite aut male institutae, tales sequuntur philosophiae et contemplationes. Fallunt autem et incompetentes sunt eae quibus utimur in universo illo processu, qui a sensu et rebus ducit ad axiomata et conclusiones. Qui quidem processus quadruplex [66] est, et vitia ejus totidem. Primo, impressiones sensus

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[63] It would seem from this passage as if the 'pravae demonstrationes' were to be discussed as supplemental to the 'idola.' But they are themselves (see Aph. 61) a subdivision of the 'idola theatri,' which originate 'ex fabulis theoriarum et perversis legibus demonstrationum.'

[64] This is a good example of the pregnancy and suggestiveness of many of Bacon's sayings. It is singularly applicable to many metaphysical systems, both ancient and modern. Men, neglecting the facts of nature and mind, often attempt to construct an a priori system of the universe, 'enslaving the world to their own thoughts,' while their thoughts themselves are concealed and fettered in the meshes of a technical terminology.

Cp. De Principiis atque Originibus, secundum fabulas Cupidinis et Coeli (E. and S., vol. iii. pp. 85–6): 'Itaque hi omnes' (Empedocles, Anaxagoras, &c.) 'mentem rebus submiserunt. At Plato mundum cogitationibus, Aristoteles vero etiam cogitationes verbis, adjudicarunt.'

[65] Thus, for instance, the failure of the ancients in the Physical Sciences is due largely to their disproportionate employment of the Deductive method. Their success, on the other hand, in some branches of Mathematics was due to the extent to which this method had been already elaborated.

Again, it has often been remarked that fundamental differences in opinion generally turn on fundamental differences in method. Thus, the method of Locke, which is mainly inductive, and the method of Descartes, which is mainly a priori, result in two widely different systems of mental philosophy. The introspective method of Butler and the historical method of Hume, again, though both of them essentially inductive, lead to very divergent theories of ethics. The position, in fact, might be illustrated to almost any extent in the history of either ancient or modern philosophy.

[66] Bacon points out four respects in which the present methods of demonstration are defective:

(1) The senses frequently fail or deceive us;

(2) Our notions are confused and ill-defined;

ipsius vitiosae sunt; sensus enim et destituit et fallit. At destitutionibus substitutiones, fallaciis rectificationes debentur[67]. Secundo, notiones ab impressionibus sensuum male abstrahuntur, et interminatae et confusae sunt, quas terminatas et bene finitas esse oportuit. Tertio, inductio mala est, quae per enumerationem simplicem principia concludit scientiarum, non adhibitis exclusionibus et solutionibus, sive separationibus naturae debitis[68]. Postremo, modus ille inveniendi et probandi, ut primo principia maxime generalia constituantur, deinde media axiomata ad ea applicentur et probentur, errorum mater est, et scientiarum omnium calamitas[69]. Verum de istis, quae jam obiter perstringimus,

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(3) We employ the vicious method of Inductio per Enumerationem Simplicem;

(4) We fly off at once to the principia maxime generalia, instead of ascending to them gradually through the axiomata infima and media.

[67] Bacon might have added that the substitutions are to be supplied mainly by instruments, the rectifications mainly by methods.

[68] In opposition to the ordinary method of Inductio per Enumerationem Simplicem, Bacon proposes a method of elimination. It is not, however, quite clear what is the precise character of the method which he has in view. We may take his words either in a general sense or with special reference to the methods described in Book ii. In the former case, the passage might be paraphrased as follows: 'We ought to exclude all instances which do not throw light on the object of enquiry, resolve complex into more simple cases, and isolate phenomena so as to simplify our investigations.' According to the latter alternative, he has in mind the process described in Bk. ii. Aphs. 18, 19. The true method of induction, Bacon appears to have thought, was to draw up tables of presence, absence, &c., and then, by means of these, to reject out of all the possible explanations, causes, or forms of the phenomenon, first one, and then another, thus leaving a residuum of explanations, or possible causes, out of which the true one was to be found. If one only remained, this would be the true explanation, cause, or 'form,' 'forma affirmativa, solida, et vera, et bene terminata' (ii. 16). If more than one remained, the 'exclusiva' might be perfected by means of the 'praerogativae instantiarum' and other 'aids of the understanding' (see ii. 21), till, at last, the search was narrowed down to some one 'form,' which would be the form required, or to a small number amongst which the true form, cause, or explanation would have to be sought in all future investigations. For further information on Bacon's 'Method of Exclusions,' see Introduction, § 9.

[69] See note on Aph. 19, where it is shewn that the fault lies not so much in framing these wide hypotheses, as in taking them for ascertained truths and not insisting on their due verification.

fusius[70] dicemus, quum veram interpretandae naturae viam, absolutis istis expiationibus et expurgationibus mentis, proponemus.

LXX.

Sed demonstratio longe optima est experientia[71]; modo haereat in ipso experimento. Nam si traducatur ad alia quae similia existimantur, nisi rite et ordine fiat illa traductio, res fallax est[72]. At modus experiendi, quo homines nunc utuntur, caecus est et stupidus[73]. Itaque cum errant et

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[70] Mr. Kitchin refers to i. 100–105. I think that the reference is rather to the Second Book.

[71] We may, perhaps, here detect the germ of the doctrine, afterwards propounded with such emphasis by Locke and his successors, that all our knowledge may ultimately be traced to experience. That this is the case even with Geometrical Axioms (one of the strongest instances in opposition to this doctrine adduced by the rival school of psychologists) has been recently argued on novel grounds, and with a force amounting almost to demonstration, by Professor Helmholtz, following Riemann, in an article in 'Mind,' No. 3.

[72] The detection of a law of Causation can alone warrant us in founding a general conclusion on our observations and experiments. On the distinction between Laws of Causation and Empirical Laws, which are 'unfit to be relied on beyond the limits of time, place, and circumstance, in which the observations have been made,' see Mill's Logic, bk. iii. ch. 16. Mr. Mill, however, uses the expression 'Empirical Laws' somewhat loosely. It would be better to confine it entirely to the results of Inductio per Enumerationem Simplicem as distinguished from the results given by the Inductive Methods, in which there is always some evidence of facts of causation. See my Inductive Logic, ch. 4 (3rd Ed. pp. 219–221).

There are many departments of knowledge and practice in which it is almost impossible to exaggerate the importance of insisting on a precise repetition of *all* the circumstances (or, at least, all the material circumstances) of the case, before inferring that the same result will recur. This is strikingly illustrated by the widely different effects of medicines in different climates. See, for instances, the Introduction to Dr. Paris' Pharmacologia, pp. 120–123.

[73] The faults in experimentation as then practised, which are noted by Bacon in this Aphorism, may be enumerated as five:

(1) Undue extension of inferences based on experience to other instances apparently similar, without sufficient caution in allowing for possible differences of circumstances;

(2) Hap-hazard experiment, without pursuing any definite order or making any selection of instances.

(3) Insufficient variation of experiments;

vagantur nulla via certa[74], sed ex occursu rerum tantum consilium capiunt, circumferuntur ad multa, sed parum promovent; et quandoque gestiunt, quandoque distrahuntur; et semper inveniunt quod ulterius quaerant. Fere autem ita fit, ut homines leviter et tanquam per ludum experiantur, variando paululum experimenta jam cognita; et, si res non succedat, fastidiendo et conatum deserendo. Quod si magis serio et constanter ac laboriose ad experimenta se accingant, tamen in uno aliquo experimento eruendo operam collocant; quemadmodum Gilbertus in magnete, Chymici in auro. Hoc autem faciunt homines instituto non minus imperito quam tenui. Nemo enim alicujus rei naturam in ipsa re feliciter perscrutatur; sed amplianda est inquisitio ad magis communia.

Quod si etiam scientiam quandam et dogmata ex experimentis moliantur; tamen semper fere studio praepropero et intempestivo deflectunt ad praxin: non tantum propter usum et fructum ejusmodi praxeos, sed ut in opere aliquo novo

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(4) Pursuit of one experiment, or subject, to the neglect of all others;
(5) Excessive eagerness to arrive at the practical application.

The account of the last three of these faults is borrowed from Mr. Kitchin's note. He gives a fourfold division, but, though there is some obscurity in the early part of the Aphorism, I am inclined to think that the passage from 'Sed demonstratio' down to 'deserendo' is intended to specify three distinct faults.

[74] Bacon is here probably alluding to the fashion of trying experiments without any order or method, 'mera palpatio' as he calls it in Aph. 100 and the De Augmentis. Cp. lib. v. cap. 2: 'Ars ista Indicii (ita enim eam appellabimus) duas habet partes. Aut enim defertur Indicium *ab experimentis ad experimenta*; aut *ab experimentis ad axiomata*, quae et ipsa *nova experimenta* designent. Priorem harum Experientiam Literatam nominabimus, posteriorem vero Interpretationem Naturae, sive Novum Organum. Prior quidem (ut alibi attigimus) vix pro Arte habenda est aut parte Philosophiae, sed pro Sagacitate quadam: unde etiam eam Venationem Panis (hoc nomen ex fabula mutuati) quandoque appellamus. Attamen quemadmodum possit quis in via sua triplici modo progredi; aut cum *palpat ipse in tenebris*; aut cum *alterius manu ducatur, ipse parum videns*; aut denique cum *vestigia lumine adhibito regat*: similiter cum quis *experimenta omnigena absque ulla serie aut methodo tentet*, ea demum mera est palpatio; cum vero *nonnulla utatur in experimentando directione et ordine*, perinde est ac si manu ducatur: atque hoc illud est quod per Experientiam Literatam intelligimus. Nam *Lumen ipsum*, quod tertium fuit, ab Interpretatione Naturae, sive Novo Organo, petendum est.'

veluti pignus sibi arripiant, se non inutiliter in reliquis versaturos: atque etiam aliis se venditent[75], ad existimationem meliorem comparandam de iis in quibus occupati sunt. Ita fit ut, more Atalantae[76], de via decedant ad tollendum aureum pomum; interim vero cursum interrumpant, et victoriam emittant e manibus. Verum in experientiae vero curriculo eoque ad nova opera producendo, Divina Sapientia[77] omnino et ordo pro exemplari sumenda sunt. Deus autem primo die creationis lucem tantum creavit, eique operi diem integrum attribuit; nec aliquid materiati operis eo die creavit. Similiter et ex omnimoda experientia, primum inventio causarum et axiomatum verorum elicienda est: et lucifera experimenta, non fructifera quaerenda[78]. Axiomata autem recte inventa et constituta praxin non strictim sed confertim instruunt; et operum agmina ac turmas post se trahunt. Verum de experiendi viis, quae non minus quam viae judicandi obsessae sunt et interclusae, postea dicemus[79]; impraesentiarum de experientia vulgari, tanquam de mala demonstratione, tantum loquuti. Jam vero postulat ordo rerum, ut de iis quorum paulo ante mentionem fecimus, signis, quod philosophiae et contemplationes in usu male se habeant, et de causis rei primo intuitu tam mirabilis et incredibilis, quaedam

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[75] 'Puff themselves,' as tradesmen puff their wares, is the explanation which Mr. Kitchin rightly gives of this phrase.

[76] Bacon is very fond of this comparison. For the Fable and its interpretation, see De Sapientia Veterum, Fab. 25, 'Atalanta sive Lucrum.'

[77] In the text of the first Edition, we have Prudentia, but, in the list of Errata at the end of the Book, Sapientia is substituted.

[78] Bacon frequently employs this metaphor. He conceived that the 'light-bearing experiments' would bring more fruit at the last. There is, therefore, no contradiction between what he says here and in those passages where he insists on the practical aims of his philosophy, such, for instance, as that in Aph. 81: 'Meta autem scientiarum vera et legitima non alia est quam ut dotetur vita humana novis inventis et copiis.'

The history of science abounds in instances of discoveries which at first appeared to have no practical bearing, though they have subsequently resulted in the most important additions to human power and the conveniences of life. It will be sufficient to mention the elasticity of steam and the phenomena of electricity and magnetism.

[79] The reference may be to i. 98–107, but it is more probably to Bk. ii. in general, or, perhaps, specially to the Aphorisms on the Praerogativae Instantiarum.

subjungamus. Signorum enim notio praeparat assensum: causarum vero explicatio tollit miraculum. Quae duo ad extirpationem *idolorum* ex intellectu faciliorem et clementiorem multum juvant.

LXXI.[80]

Scientiae, quas habemus, fere a Graecis fluxerunt. Quae enim scriptores Romani, aut Arabes[81], aut recentiores addiderunt, non multa aut magni momenti sunt: et qualiacunque sint, fundata sunt super basin eorum quae inventa sunt a Graecis. Erat autem sapientia Graecorum professoria, et in disputationes effusa[82]: quod genus inquisitioni veritatis adversissimum est. Itaque nomen illud sophistarum[83], quod per contemptum ab iis, qui se philosophos haberi voluerunt,

[80] Here begin the five signs of the weakness and insufficiency of the preceding philosophies. The first sign which is taken from their origin amongst the Greeks, is discussed under two heads: (*a*) 'ex ortu et gente philosophiae,' treated in Aph. 71; (*β*) 'ex natura temporis et aetatis,' treated in Aph. 72.

[81] It is almost needless to observe that this censure is too severe. The Romans might, at least, have been credited with the mechanical skill which enabled them to construct such magnificent roads, aqueducts, bridges, amphitheatres, &c., and the Arabians (even if Bacon despised the share they had in reviving the study of the Aristotelian philosophy in Europe) with their part in the invention of our present numerals and of the science of Algebra, with the discovery of distillation, with their contributions to the science of medicine, with the first essays at a science of chemistry, &c. In the desire to lay the foundations of a new method and a new body of science, there can be no question that Bacon was disposed to undervalue what had already been achieved. Towards the 'recentiores' he assumes a fairer tone in Aph. 109.

[82] In this tendency to questioning and disputation, however, originated philosophy and abstract speculation. The Hindoos and Greeks alone, in the ancient world, appear to have possessed such a tendency in any marked degree. Without it, poetry, practical inventions, and maxims of conduct are possible, but not philosophy, or, to any great extent, even scientific theory.

[83] The following sentences are remarkable, as containing a view of the Sophists which has now been rendered familiar to English readers by the works of Mr. Lewes and Mr. Grote. In pointing out the original application of the term 'Sophists' to all philosophers indifferently, in glancing at the connection between the Sophists properly so called and the Rhetors, and in specifying the wandering life and the taking of fees as the characteristics mainly distinguishing the Sophists so-called from the philosophers so-called, Bacon undoubtedly anticipates some of the principal points for which Mr. Grote contends.

in antiquos rhetores rejectum et traductum est, Gorgiam, Protagoram, Hippiam, Polum, etiam universo generi competit, Platoni, Aristoteli, Zenoni, Epicuro, Theophrasto, et eorum successoribus, Chrysippo, Carneadi, reliquis. Hoc tantum intererat: quod prius genus vagum fuerit et mercenarium, civitates circumcursando, et sapientiam suam ostentando, et mercedem exigendo; alterum vero solennius et generosius, quippe eorum qui sedes fixas habuerunt, et scholas aperuerunt, et gratis philosophati sunt. Sed tamen utrumque genus (licet caetera dispar) professorium erat, et ad disputationes rem deducebat, et sectas quasdam atque haereses philosophiae instituebat et propugnabat: ut essent fere doctrinae eorum (quod non male cavillatus est Dionysius in Platonem) *Verba otiosorum senum ad imperitos juvenes* [84]. At antiquiores illi ex Graecis [85], Empedocles, Anaxagoras, Leucippus, Democritus,

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Cp. a similar passage in the Redargutio Philosophiarum (E. and S., vol. iii. pp. 565–6), where he ranks Plato and Aristotle amongst the Sophists, distinguishing favourably from them Empedocles, Heraclitus, Democritus, Anaxagoras, and Parmenides: 'Neque enim reperietis hos scholas aperuisse, sed tandem speculationes et inventa sua in scripta redegisse, et posteris transmisisse.' Of Plato and Aristotle he says: 'Itaque non haesitabo apud vos dicere, me locum Platoni et Aristoteli tribuere inter Sophistas: sed tanquam ordinis emendati et reformati. Eandem enim rem prorsus video. Aberat fortasse loci mutatio et circumcursatio, et mercedis indignitas, et inepta ostentatio; atque lucet in illis certe quiddam solennius et nobilius; sed aderant schola, auditor, secta. Itaque genus ipsum profecto cernitis.'

[84] The story is given by Diogenes Laertius, lib. iii. segm. 18: *Τρὶς δὲ πέπλευκεν εἰς Σικελίαν· πρῶτον μὲν κατὰ θέαν τῆς νήσου καὶ τῶν κρατήρων, ὅτε καὶ Διονύσιος ὁ Ἑρμοκράτους, τύραννος ὤν, ἠνάγκασεν ὥστε συμμίξαι αὐτῷ. ὁ δέ, διαλεγόμενος περὶ τυραννίδος, καὶ φάσκων ὡς οὐκ ἔστι τοῦτο κρεῖττον ὃ συμφέρον αὐτῷ μόνον, εἰ μὴ καὶ ἀρετῇ διαφέροι, προσέκρουσεν αὐτῷ· ὀργισθεὶς γάρ, Οἱ λόγοι σου, φησί, γεροντιῶσι· καὶ ὅς, Σοῦ δέ γε τυραννιῶσιν.*

[85] M. Bouillet calls attention to a passage in the Redargutio Philosophiarum (E. and S., vol. iii. pp. 569, 570), shewing the attention with which Bacon professed to have studied these philosophers: 'Scitote nos summa cum diligentia et cura omnes vel tenuissimas auras circa horum virorum opiniones et placita captasse: ut quicquid de illis, vel dum ab Aristotele confutantur, vel dum a Platone et Cicerone citantur, vel in Plutarchi fasciculo, vel in Laertii vitis, vel in Lucretii poemate, vel in aliquibus fragmentis, vel in quavis alia sparsa memoria et mentione, inveniri possit, evolverimus; neque cursim aut contemptim, sed cum fide et deliberatione examinaverimus.'

Parmenides, Heraclitus, Xenophanes, Philolaus, reliqui (nam Pythagoram, ut superstitiosum [86], omittimus), scholas (quod novimus) non aperuerunt: sed majore silentio, et severius, et simplicius, id est, minore cum affectatione et ostentatione, ad inquisitionem veritatis se contulerunt. Itaque et melius, ut arbitramur, se gesserunt; nisi quod opera eorum a levioribus istis, qui vulgari captui et affectui magis respondent ac placent, tractu temporis extincta sint: tempore (ut fluvio) leviora et magis inflata ad nos devehente, graviora et solida mergente [87]. Neque tamen isti a nationis vitio [88] prorsus immunes erant: sed in ambitionem et vanitatem sectae condendae et aurae popularis captandae nimium propendebant. Pro desperata autem habenda est veritatis inquisitio, cum ad hujusmodi inania deflectat. Etiam non omittendum videtur judicium illud, sive vaticinium potius, sacerdotis Aegyptii de Graecis [89]: *Quod semper pueri essent; neque haberent antiquitatem scientiae, aut scientiam antiquitatis.* Et certe habent id quod puerorum est; ut ad garriendum prompti sint, generare autem non possint: nam verbosa videtur sapientia eorum, et operum sterilis. Itaque ex ortu et gente philosophiae quae in usu est, quae capiuntur signa bona non sunt.

LXXII.

Neque multo meliora sunt signa quae ex natura temporis et aetatis capi possunt, quam quae ex natura loci et nationis. Angusta enim erat et tenuis notitia per illam aetatem vel temporis vel orbis [90]: quod longe pessimum est, praesertim iis

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[86] Cp. Aph. 65.

[87] This is a good instance of False Analogy. Bacon, as Mr. Kitchin observes, seems partial to this metaphor. It occurs again almost immediately in Aph. 77, as well as in other places.

[88] 'Erat autem sapientia Graecorum professoria, et in disputationes effusa.'

[89] See Plato, Timaeus, p. 22 b: *Καί τινα εἰπεῖν τῶν ἱερέων* (one of the Egyptian priests) *εὖ μάλα παλαιόν· Ὦ Σόλων, Σόλων, Ἕλληνες ἀεὶ παῖδές ἐστε, γέρων δὲ Ἕλλην οὐκ ἔστιν. Ἀκούσας οὖν, πῶς τί τοῦτο λέγεις; φάναι. Νέοι ἐστέ, εἰπεῖν, τὰς ψυχὰς πάντες· οὐδεμίαν γὰρ ἐν αὐταῖς ἔχετε δι' ἀρχαίαν ἀκοὴν παλαιὰν δόξαν οὐδὲ μάθημα χρόνῳ πολιὸν οὐδέν.*

[90] We must recollect how rapidly the knowledge of the surface of the globe had been spreading in the time of Bacon and that immediately preceding him. To say nothing of earlier discoverers; Drake, Frobisher,

qui omnia in experientia ponunt. Neque enim mille annorum [91] historiam, quae digna erat nomine historiae, habebant; sed fabulas et rumores antiquitatis. Regionum vero tractuumque mundi exiguam partem noverant: cum omnes hyperboreos, Scythas, omnes occidentales, Celtas indistincte appellarent; nil in Africa ultra citimam Aethiopiae partem, nil in Asia ultra Gangem, multo minus novi orbis provincias, ne per auditum sane aut famam aliquam certam et constantem, nossent; imo et plurima climata et zonae, in quibus populi infiniti spirant et degunt, tanquam inhabitabiles ab illis pronuntiata sint; quinetiam peregrinationes Democriti, Platonis, Pythagorae, non longinquae profecto, sed potius suburbanae, ut magnum aliquid celebrarentur. Nostris autem temporibus, et novi orbis partes complurēs et veteris orbis extrema undique innotescunt; et in infinitum experimentorum cumulus excrevit. Quare si ex nativitatis aut geniturae tempore (astrologorum more) signa capienda sint, nil magni de istis philosophiis significari videtur.

LXXIII.

Inter signa, nullum magis certum aut nobile est, quam quod ex fructibus. Fructus enim et opera inventa pro veritate philosophiarum velut sponsores et fidejussores sunt. Atque ex philosophiis istis Graecorum, et derivationibus earum per particulares scientias, jam per tot annorum spatia, vix unum experimentum adduci potest, quod ad hominum statum levandum et juvandum spectet, et philosophiae

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Raleigh, and the three Hawkinses were all his contemporaries. Hence, the geographical knowledge possessed by the ancients was already beginning to appear contemptible. The frontispiece of the first edition of the Novum Organum represents a vessel in full sail, passing between two pillars, with the motto 'Multi pertransibunt, et augebitur scientia.' (Dan. xii. 4.)

[91] In the 'Praise of Knowledge,' given in Spedding's Letters and Life of Bacon (vol. i. p. 124), Bacon says: 'The Greeks knew (except fables) not much above five hundred years before themselves.' Taking roughly the period of literary activity amongst the Greeks at five hundred years, the two passages would be consistent.

Mr. Grote is of opinion that we have no trustworthy information regarding Greek history till the first recorded Olympiad, 776 B.C. We must, of course, distinguish between definite historical statements and the evidence afforded by institutions, customs, language, &c., which may stretch much further back.

speculationibus ac dogmatibus vere acceptum referri possit[92]. Idque Celsus[93] ingenue ac prudenter fatetur; nimirum, experimenta medicinae primo inventa fuisse, ac postea homines circa ea philosophatos esse et causas indagasse et assignasse; non ordine inverso evenisse, ut ex philosophia et causarum cognitione ipsa experimenta inventa aut deprompta essent. Itaque mirum non erat, apud Aegyptios (qui rerum inventoribus divinitatem et consecrationem attribuerunt) plures fuisse brutorum animalium imagines quam hominum: quia bruta animalia, per instinctus naturales, multa inventa pepererunt; ubi homines, ex sermonibus et conclusionibus rationalibus, pauca aut nulla exhibuerint.

At Chymicorum industria nonnulla peperit; sed tanquam fortuito et obiter, aut per experimentorum quandam variationem (ut mechanici solent), non ex arte aut theoria aliqua; nam ea, quam confinxerunt, experimenta magis perturbat, quam juvat. Eorum etiam, qui in magia (quam vocant) naturali[94] versati sunt, pauca reperiuntur inventa; eaque levia, et imposturae propiora. Quocirca, quemadmodum in religione cavetur, ut fides ex operibus monstretur; idem etiam ad philosophiam optime traducitur, ut ex fructibus judicetur et vana habeatur quae sterilis sit: atque eo magis si, loco fructuum uvae et olivae, producat disputationum et contentionum carduos et spinas.

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[92] With regard to mechanical inventions, this charge is, in the main, true. These, so far as they existed in the ancient world, seem to have been due to the Egyptians and the Oriental nations rather than to the Greeks, whose intellect was speculative and aesthetic rather than practical.

It should be noticed that Bacon ignores the whole aesthetic side of Greek development.

[93] 'Repertis deinde medicinae remediis homines de rationibus eorum disserere coepisse: nec post rationem medicinam esse inventam, sed post inventam medicinam rationem esse quaesitam.' Celsus de Re Medica. Praefatio.

'But this remark,' says Mr. Ellis, 'is not made by Celsus as the expression of his own opinion; on the contrary it occurs in his statement of the views entertained by the empirical school of medicine, to which he is decidedly opposed. The error of citing Celsus as an authority for it is repeated in several parts of Bacon's works.' Mr. Spedding refers to De Augmentis, v. 2. Other places are Valerius Terminus (E. and S., vol. iii. p. 232) and the Redargutio Philosophiarum (vol. iii. p. 578).

[94] Cp. note 6 on Aph. 5.

LXXIV.

Capienda etiam sunt signa ex incrementis et progressibus philosophiarum et scientiarum. Quae enim in natura fundata sunt, crescunt et augentur: quae autem in opinione, variantur, non augentur[95]. Itaque si istae doctrinae plane instar plantae a stirpibus suis revulsae non essent, sed utero naturae adhaererent atque ab eadem alerentur, id minime eventurum fuisset, quod per annos bis mille jam fieri videmus: nempe, ut scientiae suis haereant vestigiis, et in eodem fere statu maneant, neque augmentum aliquod memorabile sumpserint; quin potius in primo authore maxime floruerint, et deinceps declinaverint. In artibus autem mechanicis[96], quae in natura

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[95] This is one of Bacon's happiest thoughts. I may add that, if in any subject we have a mere variation of opinion, without growth, it proves either that the subject is incapable of scientific treatment, or else that the scientific mode of treating it has not yet been discovered. Thus, the ontological problems, which constituted so large a part of the Greek philosophy, did not, I conceive, admit of any scientific solution, while to much of the physical speculation of the Greek philosophers no scientific treatment had yet been applied.

It has often been brought as a charge against the moral and mental sciences that they are a mere record of opinions, and admit of no growth. Provided, however, to adopt Bacon's language, they are 'founded in nature,' that is to say, in the study of man and society, I believe this charge to be emphatically untrue. The phenomena, indeed, are here more complex than in the physical sciences, and there is a larger amount of uneducated opinion to be replaced by the results of scientific investigation; hence, undoubtedly, the process of growth is slower, but I believe that with each generation of cultivated men, the materials for a knowledge of mind, life, and conduct are surely accumulating, while scientific conceptions, when once applied to these materials, admit of constant development and further and further applications. It may be added that in these sciences, owing to the exceeding familiarity of the phenomena with which they deal, there are certain early generalizations which it is comparatively easy to make; and hence, in the philosophies of Plato and Aristotle, there is a larger amount of sound speculation in these departments than in any others. But, though, perhaps, they are amongst the first to blossom, they are the last to ripen.

[96] Cp. Cogitata et Visa (E. and S., p. 616): 'Artes enim Mechanicas, ut aurae cujusdam vitalis participes, quotidie crescere et perfici; Philosophiam vero statuae more adorari et celebrari, nec moveri. Atque illas in primis authoribus rudes et fere informes ac onerosas se ostendere: postea novas vires et commoditates adipisci. Hanc autem in primo quoque authore maxime vigere, ac deinceps declinare. Neque aliam

et experientiae luce fundatae sunt, contra evenire videmus: quae (quamdiu placent) veluti spiritu quodam repletae continuo vegetant et crescunt; primo rudes, deinde commodae, postea excultae, et perpetuo auctae.

LXXV.

Etiam aliud signum capiendum est (si modo signi appellatio huic competat; cum potius testimonium sit, atque adeo testimoniorum omnium validissimum); hoc est, propria confessio authorum, quos homines nunc sequuntur. Nam et illi qui tanta fiducia de rebus pronuntiant, tamen per intervalla cum ad se redeunt, ad querimonias de naturae subtilitate, rerum obscuritate, humani ingenii infirmitate, se convertunt [97]. Hoc vero si simpliciter fieret, alios fortasse, qui sunt timidiores, ab ulteriori inquisitione deterrere, alios vero, qui sunt ingenio alacriori et magis fidenti, ad ulteriorem progressum acuere et incitare possit. Verum non satis illis est de se confiteri, sed quicquid sibi ipsis aut magistris suis incognitum aut intactum fuerit id extra terminos possibilis ponunt, et tanquam ex arte [98] cognitu aut factu impossibile pronuntiant: summa superbia et invidia suorum inventorum infirmitatem in naturae ipsius calumniam et aliorum omnium desperationem vertentes. Hinc schola Academiae novae; quae *acatalepsiam* ex professo tenuit, et homines ad sempiternas tenebras damnavit [99]. Hinc

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hujus contrarii successus causam veriorem esse, quam quod in Mechanicis multorum ingenia in unum coëunt; in Philosophia autem, singulorum ingenia ab uno quopiam destruuntur. Nam postquam dedititii facti sunt, amplitudinem non addere; sed in uno ornando aut stipando servili officio occupari. Quare omnem philosophiam ab experientiae radicibus ex quibus primum pullulavit et incrementum cepit avulsam, rem mortuam esse.'

[97] Compare, for instance, the words ascribed to Xenophanes:

> *Καὶ τὸ μὲν οὖν σαφὲς οὔτις ἀνὴρ ἴδεν οὐδέ τις ἔσται*
> *εἰδώς, ἀμφὶ θεῶν τε καὶ ἅσσα λέγω περὶ πάντων·*
> *εἰ γὰρ καὶ τὰ μάλιστα τύχοι τετελεσμένον εἰπών,*
> *αὐτὸς ὅμως οὐκ οἶδε· δοκὸς δ' ἐπὶ πᾶσι τέτυκται.*

[98] 'As if on the authority of their art,' or perhaps 'as if they had scientific grounds for saying so.'

[99] From what has already been said on the New Academy (Aph. 37, n. 41), it will be seen that this is an exaggerated view of their position. Though they rejected 'certainty,' they constituted various grades of probability, and, therefore, can hardly be said to have condemned men to eternal darkness.

opinio, quod formae sive verae rerum differentiae (quae revera sunt leges actus puri) inventu impossibiles sint, et ultra hominem[1]. Hinc opiniones illae in activa et operativa parte: calorem solis et ignis toto genere differre[2]; ne scilicet homines putent se per opera ignis aliquid simile iis quae in natura fiunt educere et formare posse. Hinc illud: compositionem tantum opus hominis, mistionem vero opus solius naturae esse[3]; ne scilicet homines sperent aliquam ex arte corporum naturalium generationem aut transformationem. Itaque ex hoc signo homines sibi persuaderi facile patientur, ne cum dogmatibus non solum desperatis, sed etiam desperationi devotis, fortunas suas et labores misceant.

LXXVI.

Neque illud signum praetermittendum est, quod tanta fuerit inter philosophos olim dissensio et scholarum ipsarum varietas: quod satis ostendit, viam a sensu ad intellectum[4] non bene munitam fuisse, cum eadem materia philosophiae (natura scilicet rerum) in tam vagos et multiplices errores abrepta fuerit et distracta. Atque licet hisce temporibus

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[1] On Bacon's use of the word Form, see Introduction, § 8.

The opinion that the discovery of the Form is impossible is discussed again in Bk. ii. Aphs. 2, 3, and also in De Augmentis, lib. iii. cap. 4, Valerius Terminus (E. and S., vol. iii. p. 239), and other places. Some of these passages are considered in the Introduction.

[2] In the 'Instantiae convenientes in natura calidi' in Bk. ii, both these descriptions of heat are included.

Apostrophising Galen in the Temporis Partus Masculus (E. and S., vol. iii. p. 531), Bacon breaks out: 'O canicula! O pestis! . . . . tu inter calores astri et ignis seditionem avide arripiens et ostentans, ubique humanam potestatem malitiose in ordinem redigis, et ignorantiam desperatione in aeternum munire cupis.'

[3] The two processes here contrasted are mechanical and chemical composition. What follows is obscure, but it seems to mean that man may, if he is only bold enough, obtain the power of so subtly mixing ingredients, or 'superinducing Forms,' as to effect the generation of a body or the transformation of one body into another. The best explanation of the passage is to be found by comparing it with Bk. ii. Aph. 5.

Mr. Spedding says that the reference is to Galen, who in his treatise De Naturalibus Facultatibus contrasts the inwardly formative power of nature with the external operations of art.

[4] That is, from observation and experiment to indúctive generalisations, or, in other words, from facts to theories.

dissensiones et dogmatum diversitates circa principia ipsa, et philosophias integras, ut plurimum extinctae sint; tamen circa partes philosophiae innumerae manent quaestiones et controversiae; ut plane appareat, neque in philosophiis ipsis, neque in modis demonstrationum aliquid certi aut sani esse.

LXXVII.

Quod vero putant homines, in philosophia Aristotelis magnum utique consensum esse; cum post illam editam antiquorum philosophiae cessaverint et exoleverint; ast apud tempora, quae sequuta sunt, nil melius inventum fuerit; adeo ut illa tam bene posita et fundata videatur, ut utrumque tempus ad se traxerit: primo, quod de cessatione antiquarum philosophiarum post Aristotelis opera edita homines cogitant, id falsum est; diu enim postea, usque ad tempora Ciceronis et secula sequentia, manserunt opera veterum philosophorum[5]. Sed temporibus insequentibus, ex inundatione Barbarorum in imperium Romanum, postquam doctrina humana velut naufragium perpessa esset; tum demum philosophiae Aristotelis et Platonis, tanquam tabulae ex materia leviore et minus solida, per fluctus temporum servatae sunt[6]. Illud etiam de consensu fallit homines, si acutius rem introspiciant. Verus enim consensus is est, qui ex libertate judicii (re prius explorata) in idem conveniente consistit[7]. At numerus longe maximus eorum, qui in Aristotelis philosophiam consenserunt, ex praejudicio et authoritate aliorum se illi mancipavit: ut

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[5] This is shewn not only by the citations in Cicero, but also by the work of Diogenes Laertius, which, though of uncertain date, is placed by some authorities as late as the time of Constantine the Great, as well as by the references in the Christian Fathers of the third and fourth centuries.

[6] See note 87 on Aph. 71.

[7] There are really three conditions of 'verus consensus,' of which Bacon enumerates only the two last, taking probably the first for granted:

(1) The judges must be competent;

(2) The matter in question must have been thoroughly examined, before judgment is pronounced;

(3) The consent must be free, that is to say, the judges must not have been influenced by each other.

On the abuse and limits of the arguments from Authority and from Universal Consent, see my Inductive Logic, 3rd ed., pp. 285–293.

sequacitas sit potius et coitio, quam consensus[8]. Quod si fuisset ille verus consensus et late patens, tantum abest ut consensus pro vera et solida authoritate haberi debeat, ut etiam violentam praesumptionem inducat in contrarium[9]. Pessimum enim omnium est augurium, quod ex consensu capitur in rebus intellectualibus: exceptis divinis et politicis, in quibus suffragiorum jus est[10]. Nihil enim multis placet, nisi imaginationem feriat, aut intellectum vulgarium notionum nodis astringat, ut supra dictum est[11]. Itaque optime traducitur illud Phocionis[12] a moribus ad intellectualia: *Ut statim se examinare debeant homines, quid erraverint aut peccaverint, si multitudo consentiat et complaudat.* Hoc signum igitur ex aversissimis est. Itaque quod signa veritatis et sanitatis

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[8] There is a story of the late Bishop Thirlwall that, on one occasion, distinguishing between the few competent and the many incompetent signatories of a memorial, he described the latter as so many ciphers after a decimal point.

On this 'sequacitas et coitio' in the case of Aristotle, cp. the beginning of Campanella's treatise 'Philosophia sensibus demonstrata,' &c. (published at Naples in 1591), where we find him complaining: 'Et si quando quaestionem sensatae rei tractant, non quod in re est vident; sed quod in verbis Aristotelis scriptum inveniunt, et ex eis arguunt, et ex eis respondent, et si ipsa rei natura sensibus contrariam Aristoteli se offerat nolentibus et invitis, dicunt Aristotelem non errasse.' 'Hinc fugientes rerum scientias, conterunt inter se tempus de subjectis scientiarum apud Aristotelem . . . . Ita quod nunquam (Mehercule) vidi unum ex eis res inspicere, ad campos tendere, maria, et montes, ut res spectent, nec in propriis domibus, sed tantum a libris Aristotelis, et super his stant semper.' pp. 2, 3.

Many similar illustrations will be found among the passages quoted from the opponents of the Aristotelian philosophy in the Introduction, § 12.

[9] Bacon's impatience with the ever-recurring appeal to authority has, of course, here betrayed him into exaggeration. Consent, however dangerous it may be to accept it as an ultimate argument, is, there can be no doubt, rather a presumption in favour of an opinion than against it. 'Securus judicat orbis terrarum' is an over-strained axiom, but, of the two exaggerations, it is nearer the truth than the 'Pessimum omnium est augurium' &c. of Bacon.

[10] There may be a touch of irony in this exception. The allusion is to Parliaments and Councils, which decide by a majority of suffrages.

[11] See Aphs. 28 and 47.

[12] See Plutarch's Life of Phocion, ch. 8: Ἐπεὶ δὲ λέγων ποτὲ γνώμην πρὸς τὸν δῆμον εὐδοκίμει, καὶ πάντας ὁμαλῶς ἑώρα τὸν λόγον ἀποδεχομένους, ἐπιστραφεὶς πρὸς τοὺς φίλους εἶπεν· Οὐ δή πού τι κακὸν λέγων ἐμαυτὸν λέληθα;

philosophiarum et scientiarum, quae in usu sunt, male se habeant; sive capiantur ex originibus ipsarum, sive ex fructibus, sive ex progressibus, sive ex confessionibus authorum, sive ex consensu; jam dictum est.

LXXVIII.

Jam vero veniendum ad causas errorum [13], et tam diuturnae in illis per tot secula morae; quae plurimae sunt et potentissimae: ut tollatur omnis admiratio, haec quae adducimus homines hucusque latuisse et fugisse; et maneat tantum admiratio, illa nunc tandem alicui mortalium in mentem venire potuisse, aut cogitationem cujuspiam subiisse: quod etiam (ut nos existimam s) foelicitatis magis est cujusdam, quam excellentis alicujus facultatis; ut potius pro temporis partu haberi debeat, quam pro partu ingenii [14].

Primo autem tot seculorum numerus, vere rem reputanti, ad magnas angustias recidit. Nam ex viginti quinque annorum centuriis, in quibus memoria et doctrina hominum fere versatur, vix sex centuriae [15] seponi et excerpi possunt, quae scientiarum feraces earumve proventui utiles fuerunt. Sunt enim non minus temporum quam regionum eremi et vastitates. Tres enim tantum doctrinarum revolutiones et periodi recte numerari possunt: una, apud Graecos; altera,

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[13] Here begin the causes of error and of so long continuance in it. They are enumerated as fifteen.

[14] Cp. Aph. 122. One of Bacon's works is called 'Temporis Partus Masculus.' In a letter to Father Fulgentio, given in Mr. Spedding's Letters and Life of Bacon (vol. vii. p. 532), he says: 'Equidem memini me, quadraginta abhinc annis, juvenile opusculum circa has res confecisse, quod magna prorsus fiducia et magnifico titulo "Temporis Partum Maximum" inscripsi.' Of this juvenile work no trace probably is left.

[15] In the Cogitata et Visa (E. and S., pp. 613, 614), he says 'scarce five centuries.' He there makes no mention of the three periods.

As Mr. Kitchin observes, the duration of these 'three periods' is unduly narrowed. But Bacon probably wished, in estimating the duration of the Greek period, to exclude the philosophy of Plato and Aristotle, and, in estimating the duration of the modern period, to exclude the philosophy of the Schoolmen. If this be the case, we may fix the Greek period from Thales to Plato, the Roman period from Cicero or Lucretius to Marcus Aurelius, and the modern period from the beginning of the revolt against Aristotle, or, perhaps, from the invention of Printing, to Bacon's own time.

apud Romanos; ultima, apud nos, occidentales scilicet Europae nationes: quibus singulis vix duae centuriae annorum merito attribui possunt. Media mundi tempora, quoad scientiarum segetem uberem aut laetam, infelicia fuerunt. Neque enim causa est ut vel Arabum vel scholasticorum[16] mentio fiat: qui per intermedia tempora scientias potius contriverunt numerosis tractatibus, quam pondus earum auxerunt. Itaque prima causa tam pusilli in scientiis profectus ad angustias temporis erga illas propitii rite et ordine refertur.

LXXIX.

At secundo loco se offert causa illa magni certe per omnia momenti: ea videlicet, quod per illas ipsas aetates, quibus hominum ingenia et literae maxime vel etiam mediocriter floruerint, naturalis philosophia minimam partem humanae operae sortita sit. Atque haec ipsa nihilominus pro magna scientiarum matre haberi debet. Omnes enim artes et scientiae, ab hac stirpe revulsae, poliuntur fortasse et in usum effinguntur; sed nil admodum crescunt[17]. At manifestum

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[16] It is now almost superfluous to remark that Bacon is unjust both to the Arabians and to the Schoolmen. Their services to philosophy and literature cannot, it is true, be compared with those of the Greeks or Romans, or with those of the Renaissance, but it was the fashion of Bacon's age unduly to depreciate the studies and the philosophical and scientific results of the Middle Ages, as, in its turn, it has become the fashion of our own time to over-estimate them.

[17] It is somewhat difficult to reconcile Bacon's conception of Natural Philosophy, so far as we can discover it from this and the next Aphorism, with the account of it given in De Augmentis, bk. iii. In these Aphorisms, Natural Philosophy is described as 'magna ista scientiarum mater,' and as the 'root' and 'trunk' from which the arts and sciences branch. But in the De Augmentis, this language is used not of Natural Philosophy, but of the Philosophia Prima. 'Quoniam autem partitiones scientiarum non sunt lineis diversis similes, quae coëunt ad unum angulum; sed potius ramis arborum, qui conjunguntur in uno trunco (qui etiam truncus ad spatium nonnullum integer est et continuus, antequam se partiatur in ramos); idcirco postulat res, ut priusquam prioris partitionis membra persequamur, constituatur una Scientia Universalis, quae sit mater reliquarum, et habeatur in progressu doctrinarum tanquam portio viae communis antequam viae se separent et disjungant.' De Augmentis, lib. iii. cap. 1. Natural Philosophy, again, in the De Augmentis is confined to the knowledge of Nature, there being distinct divisions of philosophy assigned to the knowledge of God and the knowledge of Man. But in Aph. 80, 'philosophia

est, postquam Christiana fides recepta fuisset et adolevisset, longe maximam ingeniorum praestantissimorum partem ad theologiam se contulisse; atque huic rei et amplissima praemia proposita, et omnis generis adjumenta copiosissime subministrata fuisse: atque hoc theologiae studium praecipue occupasse tertiam illam partem sive periodum temporis apud nos Europaeos occidentales; eo magis, quod sub idem fere tempus et literae florere, et controversiae circa religionem pullulare coeperint. At aevo superiori, durante periodo illa secunda apud Romanos, potissimae philosophorum meditationes et industriae in morali philosophia (quae ethnicis vice theologiae erat[18]) occupatae et consumptae fuerunt: etiam

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moralis et civilis, et scientiae logicae' are regarded as receiving their proper nutriment from Natural Philosophy, which has for its object not only motions, rays, sounds, &c., but also 'affectus, et prehensiones intellectuales.' In the two books of the Advancement of Learning, the account of the respective functions of the Philosophia Prima and Natural Philosophy is substantially the same as that in the De Augmentis. Cp. also Bk. i. Aph. 127 of the Novum Organum. One can hardly avoid the conclusion that, in the Aphorisms now under discussion, Bacon has confounded the conception of Natural Philosophy with that of the Philosophia Prima.

This difficulty having been pointed out, the subsequent notes to these two Aphorisms must be regarded as applying to Natural Philosophy only as here understood.

[18] In the corresponding passage of the Cogitata et Visa, Gruter, though not the Queen's College MS., reads 'quae Ethnicis, magna ex parte, vice Theologiae erat.'

The Greek and Roman religions contained little theology in our sense of the term. They recognised no creeds, catechisms, or articles of faith. Nor were the priests of the classical religions, like ours, moral and religious teachers. The religion was mainly a cult, and the priests were almost exclusively the performers of rites and sacrifices. Into a man's religious convictions, so long as he kept the required religious observances, few cared to enquire. Nor, again, though certain crimes, such as homicide, the refusal of hospitality, the breach of an oath, the removal of a boundary, &c., were supposed to be avenged by certain deities, was there any definite and detailed connection between the religion and the morality of classical times. Of the divorce between the popular religion and what we understand by morality, we cannot have better examples than those adduced by Plato in the 2nd and 3rd Books of the Republic.

Hence, it naturally happened that the discussions as to the nature of the Gods and the grounds and precepts of morality fell into the hands of the philosophers. Theology, as treated by them, assumed a metaphysical character, having little or no practical bearing on the affairs of

summa ingenia illis temporibus ut plurimum ad res civiles se applicuerunt, propter magnitudinem imperii Romani, quod plurimorum hominum opera indigebat. At illa aetas, qua naturalis philosophia apud Graecos maxime florere visa est, particula fuit temporis minime diuturna; cum et antiquioribus temporibus septem illi, qui sapientes nominabantur, omnes (praeter Thaletem) ad moralem philosophiam et civilia se applicuerint; et posterioribus temporibus postquam Socrates philosophiam de coelo in terras deduxisset [19], adhuc magis invaluerit moralis philosophia, et ingenia hominum a naturali averterit.

At ipsissima illa periodus temporis, in qua inquisitiones de natura [20] viguerunt, contradictionibus et novorum placitorum ambitione corrupta est, et inutilis reddita. Itaque quandoquidem per tres istas periodos naturalis philosophia majorem in modum neglecta aut impedita fuerit, nil mirum si homines parum in ea re profecerint, cum omnino aliud egerint.

LXXX.

Accedit et illud, quod naturalis philosophia in iis ipsis viris,

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life (witness the discussions in the so-called 'Metaphysics' of Aristotle), and, consequently, possessed no attractions for ordinary men. The belief or disbelief in the propositions propounded was not regarded as likely to affect a man's lot either in this world or the next. The tendency of speculation, therefore, both among the later Greeks and the Romans, was towards a philosophy of life, character, and conduct, and this tendency amongst the Romans was specially assisted by the legal and practical direction of their minds. The favourite topics of discussion were not the nature of the Gods or our relations to them, much less our duties towards them, but our relations and duties to each other, the main objects of life, wherein consists the perfection of human nature, by what means we can attain that perfection, and other questions of a similar character. It was the answer to these questions, we might say, and not the answer to theological enquiries, which furnished the spiritual sustenance of the Greeks and Romans. Hence, Bacon's remark that moral philosophy, in classical times, supplied the place of theology, if not accurately, is at least approximately true.

[19] See Cicero's Tusculan Disputations, bk. v. ch. 4: 'Socrates autem primus philosophiam devocavit e coelo, et in urbibus collocavit, et in domos etiam introduxit, et coegit de vita, et moribus, rebusque bonis et malis quaerere.' Cp. Academics, i. 4.

[20] In this concluding paragraph, Bacon seems to employ the phrase Natural Philosophy in the same sense as in the De Augmentis.

qui ei incubuerint, vacantem et integrum hominem, praesertim his recentioribus temporibus, vix nacta sit; nisi forte quis monachi alicujus in cellula, aut nobilis in villula lucubrantis, exemplum adduxerit[21]: sed facta est demum naturalis philosophia instar transitus cujusdam et pontisternii ad alia.

Atque magna ista scientiarum mater mira indignitate ad officia ancillae detrusa est; quae medicinae aut mathematices[22] operibus ministret, et rursus quae adolescentium immatura ingenia lavet et imbuat velut tinctura quadam prima, ut aliam postea foelicius et commodius excipiant. Interim nemo expectet magnum progressum in scientiis (praesertim in parte earum operativa), nisi philosophia naturalis ad scientias particulares producta fuerit, et scientiae particulares rursus ad naturalem philosophiam reductae. Hinc enim fit, ut astronomia, optica, musica, plurimae artes mechanicae, atque ipsa medicina, atque (quod quis magis miretur) philosophia moralis et civilis, et scientiae logicae, nil fere habeant altitudinis in profundo: sed per superficiem et varietatem rerum tantum labantur: quia, postquam particulares istae scientiae dispertitae et constitutae fuerint, a philosophia naturali non amplius aluntur; quae ex fontibus et veris contemplationibus motuum, radiorum, sonorum, texturae, et schematismi corporum, affectuum, et prehensionum intellectualium, novas vires et augmenta illis impertiri potuerit[23].

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[21] In the Cogitata et Visa (E. and S., vol. iii. p. 595), Bacon adds 'quod et rarissimum reperietur.'

It has often been suggested that the allusions in this passage are specifically to Roger Bacon and Descartes. But Descartes had not yet (1620) published any works, and, as he was only born in 1596, he cannot possibly have been alluded to by Bacon in the Cogitata et Visa, which was composed about 1607.

[22] In the De Augmentis, Mathematics are called the 'great Appendix' of Natural Philosophy (lib. iii. cap. 6), while Medicine is one of the divisions of Human Philosophy, 'Doctrina de Homine' (lib. iv. cap. 2).

[23] Apart from the question of the appropriate or inappropriate use of the term 'Natural Philosophy,' there can be little question that Bacon's thought here is a just one. Every special art or science ought to be treated in reference to the general science under which it falls. Thus, Logic is empirical, unless based on Psychology, Medicine, unless based on a knowledge of Physiology, Mechanics, unless based on the Laws of Motion, Force, &c., and so on throughout the sciences. Bacon seems here to have conceived of Natural Philosophy as the one general science

Itaque minime mirum est si scientiae non crescant, cum a radicibus suis sint separatae.

LXXXI.

Rursus se ostendit alia causa potens et magna, cur scientiae parum promoverint. Ea vero haec est; quod fieri non possit, ut recte procedatur in curriculo, ubi ipsa meta non recte posita sit et defixa. Meta autem scientiarum vera et legitima non alia est quam ut dotetur vita humana novis inventis et copiis[24].

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with which the more special sciences should be brought into connection, and which should deal with the laws of nature and man in a more comprehensive manner than it was possible for the more special sciences to do. It was to give, as it were, a general survey of nature, and then the more special sciences were to follow out in detail particular departments, never, however, losing sight of the common stock with which they were connected.

The inclusion of 'affectus et prehensiones intellectuales' among the objects of Natural Philosophy, though inconsistent with Bacon's employment of the word in the De Augmentis, is in accordance with ancient usage. The word Psychology is comparatively modern, and the questions of which that science treats were included by ancient authors under Physiology or Physics. Thus, the De Anima was always ranked among the physical works of Aristotle. In the old Statutes of the University of Oxford, among the books on which the 'Praelector Naturalis Philosophiae' was to lecture were the 'libri de Anima.' For instances of the Aristotelian use of the words 'physical' and 'physiological,' as including what we should call 'psychological,' see Eth. vii. 3 (9, 12).

[24] Cp. Cogitata et Visa (E. and S., vol. iii. p. 595): 'Metam autem non aliam esse, quam ut genus humanum novis operibus et potestatibus continuo dotetur.'

This, as I have pointed out in the Introduction (p. 127 and elsewhere), is one of the watchwords of the Baconian philosophy. But we must, at least, take it in conjunction with the maxim which Bacon is never weary of repeating: 'Lucifera experimenta, non fructifera quaerenda.' It often happens that enquiries which at first sight appear to have no practical bearing are ultimately found to contribute largely to the comforts and conveniences of life. But, even if this were not the case, it might be maintained, and maintained rightly, that knowledge should be sought for its own sake. No reason can be given why man should not be at full liberty to gratify his desire of knowledge, his curiosity to know all that is about and within him, as much as any other desire of his nature. As Bacon himself says in the Praise of Knowledge, 'Are not the pleasures of the affections greater than the pleasures of the senses? And are not the pleasures of the intellect greater than the pleasures of the affections? Is not knowledge a true and only natural pleasure, whereof there is no satiety?'

At turba longe maxima nihil ex hoc sapit, sed meritoria plane est et professoria; nisi forte quandoque eveniat, ut artifex aliquis acrioris ingenii, et gloriae cupidus, novo alicui invento det operam; quod fere fit cum facultatum dispendio. At apud plerosque tantum abest ut homines id sibi proponant, ut scientiarum et artium massa augmentum obtineat, ut ex ea, quae praesto est, massa nil amplius sumant aut quaerant, quam quantum ad usum professorium aut lucrum aut existimationem aut hujusmodi compendia convertere possint [25].

On 'the limits and end of knowledge,' there is a long chapter in the Valerius Terminus (E. and S., vol. iii. pp. 117–224). There Bacon takes, as I conceive, an unduly narrow view. 'All knowledge,' he says, 'should be referred to use and action.' 'Knowledge that tendeth but to satisfaction is but as a courtesan, which is for pleasure and not for fruit or generation.' In the same spirit, or in exaggeration of the same spirit, Comte objects to the continued cultivation of sidereal astronomy, the search into the internal constitution of the sun, and other pursuits which are not likely to contribute to the welfare of mankind. But, apart from the legitimate and often exquisite pleasure to be derived from these investigations, may they not be justified by their tendency to divert us from merely selfish aims, by the interests which they excite in objects external to ourselves, and by the widening and elevating influence which they so frequently exert on the intellect and character?

For a different and more liberal view of the relation between knowledge and practice, 'veritas et utilitas,' see Aph. 124; and cp. my notes upon it.

[25] Cp. De Augmentis, lib. i. (E. and S., vol. i. pp. 462–3): 'Omnium autem gravissimus error in deviatione ab ultimo doctrinarum fine consistit. Appetunt enim homines scientiam, alii ex insita curiositate et irrequieta; alii animi causa et delectationis; alii existimationis gratia; alii contentionis ergo, atque ut in disserendo superiores sint; plerique propter lucrum et victum; paucissimi ut donum rationis divinitus datum in usus humani generis impendant. Plane, quasi in doctrina quaereretur lectulus, in quo tumultuans ingenium et aestuans requiesceret; aut xystus sive porticus, in quo animus deambularet liber aut vagus; aut turris alta et edita, de qua mens ambitiosa et superba despectaret; aut arx et propugnaculum ad contentiones et praelia; aut officina ad quaestum et mercatum; et non potius locuples armarium et gazophylacium, ad opificis rerum omnium gloriam et vitae humanae subsidium. Hoc enim illud est, quod revera doctrinam atque artes condecoraret et attolleret, si contemplatio et actio arctiore quam adhuc vinculo copularentur. Quae certe conjunctio talis foret, qualis est supremorum duorum planetarum syzygia, cum Saturnus, quietis et contemplationis dux, cum Jove, duce societatis agendique, conspiret.'

The whole of the First Book of the De Augmentis is occupied with a defence of Knowledge and a statement of its dignity and ends.

Quod si quis ex tanta multitudine scientiam affectu ingenuo et propter se expetat; invenietur tamen ille ipse potius contemplationum et doctrinarum varietatem, quam veritatis severam et rigidam inquisitionem sequi. Rursus, si alius quispiam fortasse veritatis inquisitor sit severior; tamen et ille ipse talem sibi proponet veritatis conditionem, quae menti et intellectui satisfaciat in redditione causarum rerum quae jampridem sunt cognitae; non eam, quae nova operum pignora, et novam axiomatum lucem assequatur. Itaque, si finis scientiarum a nemine adhuc bene positus sit, non mirum est si in iis, quae sunt subordinata ad finem, sequatur aberratio.

LXXXII.

Quemadmodum autem finis et meta scientiarum male posita sunt apud homines; ita rursus etiamsi illa recte posita fuissent, viam tamen sibi delegerunt omnino erroneam et imperviam [26]. Quod stupore quodam animum rite rem reputanti perculserit; non ulli mortalium curae aut cordi fuisse, ut intellectui humano ab ipso sensu et experientia ordinata et bene condita via aperiretur et muniretur; sed omnia vel traditionum caligini, vel argumentorum vertigini et turbini, vel casus et experientiae vagae et inconditae undis et ambagibus permissa esse. Atque cogitet quis sobrie et diligenter, qualis sit ea via, quam in inquisitione et inventione alicujus rei homines adhibere consueverunt. Et primo notabit proculdubio inveniendi modum simplicem et inartificiosum, qui hominibus maxime est familiaris. Hic autem non alius est, quam ut is, qui se ad inveniendum aliquid comparat et

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[26] There is little in this Aphorism which Bacon has not already said. But it is often striking in expression, and may be taken as a summary statement of the false methods which men pursue in their enquiries. The first of these is to collect opinions and authorities, and then, by comparing them and reflecting on them, to attempt to arrive at an opinion of our own. The second is to follow the dialectical (or syllogistical) method, not examining the first principles, but either taking them for granted or borrowing them from the professors of the several arts, and then pursuing these first principles to their remote consequences, without pausing to enquire into the truth of the data on which they are based. The third and last is to consult experience, but without any definite order or method, groping, as it were, in the dark, instead of guiding our steps by a light.

accingit, primo quae ab aliis circa illa dicta sint inquirat et evolvat; deinde propriam meditationem addat, atque per mentis multam agitationem spiritum suum proprium sollicitet, et quasi invocet, ut sibi oracula pandat: quae res omnino sine fundamento est, et in opinionibus tantum volvitur.

At alius quispiam dialecticam ad inveniendum advocet, quae nomine tenus tantum ad id quod agitur pertinet. Inventio enim dialecticae non est principiorum et axiomatum praecipuorum, ex quibus artes constant, sed eorum tantum quae illis consentanea videntur. Dialectica enim magis curiosos et importunos, et sibi negotium facessentes, eamque interpellantes de probationibus et inventionibus principiorum, sive axiomatum primorum, ad fidem, et veluti sacramentum cuilibet arti praestandum, notissimo responso rejicit.

Restat experientia mera: quae, si occurrat, casus; si quaesita sit, experimentum nominatur. Hoc autem experientiae genus nihil aliud est, quam (quod aiunt) scopae dissolutae[27], et mera palpatio[28], quali homines noctu utuntur, omnia pertentando, si forte in rectam viam incidere detur; quibus multo satius et consultius foret diem praestolari, aut lumen accendere, et deinceps viam inire. At contra, verus experientiae ordo primo lumen accendit, deinde per lumen iter demonstrat, incipiendo ab experientia ordinata et digesta, et minime praepostera[29] aut erratica, atque ex ea educendo axiomata, atque ex axiomatibus constitutis rursus experimenta nova; quum nec verbum divinum in rerum massam absque ordine operatum sit.

Itaque desinant homines mirari si spatium scientiarum non

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[27] 'Loose twigs.' 'Scopas dissolvere,' to untie a broom, was a proverb for throwing anything into confusion and disorder. See Cicero, Orator, ch. 71: 'Isti autem cum dissolvunt orationem, in qua nec res, nec verbum ullum est, nisi abjectum: non clypeum, sed, ut in proverbio est (etsi humilius dictum est, tamen consimile est) scopas mihi videntur dissolvere.' There is a similar application of the proverb in the Epistles to Atticus, lib. vii. ep. 13: 'L. Caesarem vidi Minturnis, cum absurdissimis mandatis, non hominem, sed scopas solutas.' The proverb may have had its origin in the Fable of the Father and his Sons, 'as inculcating Unity.'

[28] See the passage from the De Augmentis, lib. v. cap. 2, already quoted in note 74 to Aph. 70.

[29] ὕστερον πρότερον; observing no order or method, or, perhaps, the wrong order.

confectum sit, cum a via omnino aberraverint; relicta prorsus et deserta experientia, aut in ipsa (tanquam in labyrintho) se intricando, et circumcursando; cum rite institutus ordo per experientiae sylvas[30] ad aperta axiomatum tramite constanti ducat.

LXXXIII.

Excrevit autem mirum in modum istud malum ex opinione quadam, sive aestimatione inveterata, verum tumida et damnosa; minui nempe mentis humanae majestatem, si experimentis, et rebus particularibus sensui subjectis et in materia determinatis, diu ac multum versetur: praesertim quum hujusmodi res ad inquirendum laboriosae, ad meditandum ignobiles, ad dicendum asperae, ad practicam illiberales, numero infinitae, et subtilitate tenues esse soleant[31]. Itaque jam tandem huc res rediit, ut via vera non tantum deserta, sed etiam interclusa et obstructa sit; fastidita experientia, nedum relicta, aut male administrata.

LXXXIV.

Rursus vero homines a progressu in scientiis detinuit et fere incantavit reverentia antiquitatis, et virorum, qui in

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[30] Bacon gave the title of 'Sylva Sylvarum' to his 'Ten Centuries' of 'Natural History.'

Mr. Kitchin quotes, as illustrating this metaphor, an apposite passage from one of Bacon's Fragments: 'We endeavour to penetrate and pass through the woods of Nature, thick set and darkened with a great variety of experiments, as with leaves; and entangled and twined together, like shrubs and bushes, with the subtilty of observations. We are now, perhaps, proceeding to the more open parts of Nature, which, however, are still more difficult; and, having got through the woods, are come to the bottom of the mountains.'

[31] In the Cogitata et Visa (E. and S., vol. iii. pp. 600–1) Bacon makes the same reflections, and then adds: 'Quam opinionem sive animi dispositionem, vires maximas sumpsisse ex illa altera opinione elata et commentitia, qua veritas humanae mentis veluti indigena, nec aliunde commigrans; et sensus intellectum magis excitare quam informare asserebatur. Neque tamen errorem hunc, et mentis (si verum nomen quaeratur) alienationem, ab iis ulla ex parte correctam, qui sensui debitas, id est primas partes tribuerunt. Quin et hos quoque exemplo et facto suo, relicta prorsus Naturali historia et mundana perambulatione, omnia in Ingenii agitatione posuisse, et inter opacissima mentis Idola, sub specioso contemplationis nomine, perpetuo volutasse.' The student will not fail to notice the psychological interest attaching to the early part of this quotation.

philosophia magni habiti sunt, authoritas, atque deinde consensus. Atque de consensu superius dictum est[32].

De antiquitate autem opinio, quam homines de ipsa fovent, negligens omnino est, et vix verbo ipsi congrua[33]. Mundi

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[32] Aph. 77. Cp. notes on that Aphorism, and also the passage in my Inductive Logic (3rd ed., pp. 285–293) there referred to. To the instances of extravagant respect for authority given in those places, the reader may add the following taken from Galileo's 1st Dialogue (Sir Thomas Salusbury's Translation, pp. 91–3).

'SAGREDUS. I found one day, at home in his house, at Venice, a famous phisician, to whom some flockt for their studies, and others out of curiosity sometimes came thither to see certain anatomies dissected by the hand of a no lesse learned, than careful and experienced anatomist. It chanced upon that day, when I was there, that he was in search of the original and rise of the nerves, about which there is a famous controversie between the Galenists and Peripateticks; and the anatomist shewing, how that great number of nerves departing from the brain, as their root, and passing by the nape of the neck, distend themselves afterwards along by the back-bone, and branch themselves thorow all the body; and that a very small filament, as fine as a thred, went to the heart; he turned to a gentleman whom he knew to be a Peripatetick philosopher, and for whose sake he had with extraordinary exactnesse, discovered and proved every thing, and demanded of him, if he was at length satisfied and perswaded that the original of the nerves proceeded from the brain, and not from the heart? To which the philosopher, after he had stood musing a while, answered; you have made me to see this businesse so plainly and sensibly, that did not the text of Aristotle assert the contrary, which positively affirmeth the nerves to proceed from the heart, I should be constrained to confesse your opinion to be true.'

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'SALVIATUS. And there are certain gentlemen yet living, and in health, who were present, when a doctor, that was professor in a famous academy, hearing the description of the telescope, by him not seen as then, said that the invention was taken from Aristotle, and causing his works to be fetch't, he turned to a place where the philosopher gives the reason, whence it commeth, that from the bottom of a very deep well, one may see the stars in heaven at noon day; and, addressing himself to the company, see here, saith he, the well, which representeth the tube, see here the gross vapours, from whence is taken the invention of the crystals, and see here lastly the sight fortified by the passage of the rays through a diaphonous, but more dense and obscure medium.'

On the immoderate reverence for Antiquity and Authority, cp. De Augmentis, lib. i. (E. and S., vol. i. pp. 456–459). This passage, though full of interest, is too long for quotation.

[33] The thought which Bacon here elaborates, is summed up in one short Aphorism in the parallel passage of De Augmentis, lib. i.: 'Sane, ut verum

enim senium et grandaevitas pro antiquitate vere habenda sunt; quae temporibus nostris tribui debent, non juniori aetati mundi, qualis apud antiquos fuit. Illa enim aetas, respectu nostri, antiqua et major; respectu mundi ipsius, nova et minor fuit[34]. Atque revera quemadmodum majorem rerum humanarum notitiam et maturius judicium ab homine sene expectamus quam a juvene, propter experientiam et rerum, quas vidit, et audivit, et cogitavit, varietatem et copiam; eodem modo et a nostra aetate (si vires suas nosset, et experiri et intendere vellet) majora multo quam a priscis temporibus expectari par est; utpote aetate mundi grandiore, et infinitis experimentis et observationibus aucta et cumulata.

Neque pro nihilo aestimandum, quod per longinquas navigationes et peregrinationes (quae seculis nostris increbuerunt) plurima in natura patuerint, et reperta sint, quae novam philosophiae lucem immittere possint. Quin et turpe hominibus foret, si globi materialis tractus, terrarum videlicet, marium, astrorum, nostris temporibus immensum aperti et illustrati sint; globi autem intellectualis[35] finis inter veterum inventa et angustias cohibeantur.

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dicamus, Antiquitas saeculi juventus mundi.' For a discussion of the questions whether this Aphorism is due to Bacon himself, and what traces of it are to be found in earlier writers, see a note in my Inductive Logic, 3rd ed., p. 329, and also a note by Mr. Ellis to the De Augmentis, lib. i. (E. and S., pp. 458–9). Both Rémusat and Mr. Ellis cite very appositely 2 Esdras xiv. 10: 'For the world hath lost his youth, and the times begin to wax old.'

[34] Bentham in his Book of Fallacies, part i. ch. 2, and Sydney Smith in his review of that work (Edinburgh Review, No. 84, reprinted in his Collected Works), follow up this argument in a striking and amusing manner.

M. Bouillet refers, for the same sentiment, to Pascal and Malebranche, but both his references are wrong. The right reference to Pascal is to a Fragment entitled 'Préface sur le Traité du Vide' or 'De l'autorité en matière de philosophie.' The right reference to Malebranche is to 'De la Recherche de la Vérité,' livre ii. 2me partie, ch. 4. Both passages are interesting.

[35] One of Bacon's minor works (reprinted in Ellis and Spedding's ed., vol. iii. pp. 727–768) is designated 'Descriptio Globi Intellectualis.' To it is appended the 'Thema Coeli.'

Authores vero quod attinet, summae pusillanimitatis est authoribus infinita tribuere, authori autem authorum, atque adeo omnis authoritatis, Tempori, jus suum denegare. Recte enim Veritas Temporis filia dicitur, non Authoritatis[36]. Itaque mirum non est, si fascina ista antiquitatis et authorum et consensus, hominum virtutem ita ligaverint, ut cum rebus ipsis consuescere (tanquam maleficiati) non potuerint.

LXXXV.

Neque solum admiratio antiquitatis, authoritatis, et consensus, hominum industriam in iis, quae jam inventa sunt, acquiescere compulit; verum etiam operum ipsorum admiratio, quorum copia jampridem facta est humano generi. Etenim quum quis rerum varietatem, et pulcherrimum apparatum qui per artes mechanicas ad cultum humanum congestus et introductus est, oculis subjecerit, eo certe inclinabit, ut potius ad opulentiae humanae admirationem, quam ad inopiae sensum accedat; minime advertens primitivas hominis observationes atque naturae operationes (quae ad omnem illam varietatem instar animae sunt, et primi motus) nec multas, nec alte petitas esse; caetera ad patientiam hominum tantum, et subtilem et ordinatum manus vel instrumentorum motum, pertinere[37]. Res enim (exempli gratia) subtilis est certe et accurata confectio horologiorum, talis scilicet, quae coelestia in rotis, pulsum animalium in motu successivo et ordinato, videatur imitari; quae tamen res ex uno aut altero naturae axiomate pendet.

Quod si quis rursus subtilitatem illam intueatur quae ad

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[36] See Aulus Gellius, Noctes Atticae, lib. xii. cap. 11: 'Alius quidam veterum poetarum, cujus nomen mihi nunc memoriae non est, veritatem temporis filiam esse dixit.' I am indebted for this quotation to the Rev. E. Marshall. Cp. Aeschylus, Prometheus Vinctus, l. 981:

Ἀλλ' ἐκδιδάσκει πάνθ' ὁ γηράσκων χρόνος.

[37] In the Cogitata et Visa (E. and S., vol. iii. p. 593), the following sentence occurs after the words 'motum tantum pertinere:' 'atque in hac parte officinam cum Bibliotheca mire congruere, quae et ipsa tantam librorum varietatem ostentet, in quibus si diligentius introspicias, nil aliud quam ejusdem rei infinitas repetitiones reperias, tractatu novas, inventione praeoccupatas.' The substance of this sentence, though not in so neat a form, occurs in the next paragraph but one of this Aphorism.

artes liberales pertinet; aut etiam eam quae ad corporum naturalium praeparationem per artes mechanicas spectat, et hujusmodi res suspiciat; veluti inventionem motuum coelestium in astronomia, concentuum in musica, literarum alphabeti (quae etiam adhuc in regno Sinarum in usu non sunt) in grammatica; aut rursus in mechanicis, factorum Bacchi et Cereris, hoc est, praeparationum vini et cervisiae, panificiorum, aut etiam mensae delitiarum, et distillationum, et similium: ille quoque, si secum cogitet, et animum advertat, per quantos temporum circuitus (cum haec omnia, praeter distillationes[38], antiqua fuerint) haec ad eam, quam nunc habemus, culturam perducta sint, et (ut jam de horologiis dictum est) quam parum habeant ex observationibus et axiomatibus naturae, atque quam facile, et tanquam per occasiones obvias et contemplationes incurrentes, ista inveniri potuerint: ille (inquam) ab omni admiratione se facile liberabit, et potius humanae conditionis miserebitur, quod per tot secula tanta fuerit rerum et inventorum penuria et sterilitas. Atque haec ipsa tamen, quorum nunc mentionem fecimus, inventa, philosophia et artibus intellectus antiquiora fuerunt: adeo ut (si verum dicendum sit) cum hujusmodi scientiae rationales et dogmaticae inceperint, inventio operum utilium desierit[39].

Quod si quis ab officinis ad bibliothecas se converterit, et immensam, quam videmus, librorum varietatem in admiratione habuerit, is, examinatis et diligentius introspectis ipsorum librorum materiis et contentis, obstupescet certe in contrarium; et postquam nullum dari finem repetitionibus observaverit, quamque homines eadem agant et loquantur, ab admiratione varietatis transibit ad miraculum indigentiae et paucitatis earum rerum quae hominum mentes adhuc tenuerunt et occuparunt.

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[38] Distillation is generally supposed to have been introduced into Europe by the Moors about A.D. 1150, but as regards its earlier history there is considerable difficulty. Mr. Ellis refers to Dutens, Origine des Découvertes, &c., p. 187 of the London Edition, and Humboldt's Examen critique de l'Histoire de la Géographie, &c., vol. ii. p. 306.

[39] This is, of course, an exaggeration. It is true, however, that neither science nor philosophy came into existence, or could have come into existence, till the primary wants of life were satisfied.

Quod si quis ad intuendum ea, quae magis curiosa habentur quam sana, animum submiserit, et alchymistarum aut magorum opera penitius introspexerit, is dubitabit forsitan utrum risu an lachrymis potius illa digna sint. Alchymista enim[40] spem alit aeternam, atque ubi res non succedit errores proprios reos substituit; secum accusatorie reputando, se aut artis aut authorum vocabula non satis intellexisse, unde ad traditiones et auriculares susurros animum applicat; aut in practicae suae scrupulis et momentis[41] aliquid titubatum esse, unde experimenta in infinitum repetit: ac interim quum inter experimentorum sortes in quaedam incidit aut ipsa facie nova aut utilitate non contemnenda; hujusmodi pignoribus animum pascit, eaque in majus ostentat et celebrat: reliqua spe sustentat. Neque tamen negandum est, alchymistas non pauca invenisse, et inventis utilibus homines donasse. Verum fabula illa[42] non male in illos quadrat de sene, qui filiis aurum in vinea defossum (sed locum se nescire simulans) legaverit; unde illi vineae fodiendae diligenter incubuerunt, et aurum quidem nullum repertum, sed vindemia ex ea cultura facta est uberior.

At naturalis magiae[43] cultores, qui per rerum sympathias et antipathias omnia expediunt, ex conjecturis otiosis et supinissimis, rebus virtutes et operationes admirabiles affinxerunt; atque si quando opera exhibuerint, ea illius sunt generis, ut ad admirationem et novitatem, non ad fructum et utilitatem, accommodata sint.

In superstitiosa autem magia[44] (si et de hac dicendum sit) illud inprimis animadvertendum est, esse tantummodo certi cujusdam et definiti generis subjecta, in quibus artes curiosae et superstitiosae, per omnes nationes atque aetates atque

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[40] Cp. Aphs. 54 and 73, and De Augmentis, lib. i. (E. and S., vol. i. pp. 456–7).

[41] He supposes that he has made some mistake either in weighing, or in selecting the proper moment for his manipulations.

[42] The Fable of the Father and his Sons, 'as inculcating Industry.'

[43] See note 6 on Aph. 5, and cp. Bk. ii. Aph. 9.

[44] 'Superstitious Magic' Bacon would, of course, altogether reject, though Natural Magic, in a purified form, he would admit as a branch of the 'Doctrina Operativa de Natura;' Mechanics being the other branch. See De Augmentis, lib. iii. cap. 5.

etiam religiones, aliquid potuerint aut luserint. Itaque ista missa faciamus. Interim nil mirum est, si opinio copiae causam inopiae dederit.

LXXXVI.

Atque hominum admirationi, quoad doctrinas et artes, per se satis simplici et prope puerili, incrementum accessit ab eorum astu et artificio qui scientias tractaverunt et tradiderunt. Illi enim ea ambitione et affectatione eas proponunt, atque in eum modum efformatas ac veluti personatas in hominum conspectum producunt, ac si illae omni ex parte perfectae essent et ad exitum perductae. Si enim methodum aspicias et partitiones, illae prorsus omnia complecti et concludere videntur, quae in illud subjectum cadere possunt. Atque licet membra illa male impleta et veluti capsulae inanes sint; tamen apud intellectum vulgarem scientiae formam et rationem integrae prae se ferunt.

At primi et antiquissimi veritatis inquisitores, meliore fide et fato, cognitionem illam, quam ex rerum contemplatione decerpere, et in usum recondere statuebant, in *aphorismos*[45], sive breves easdemque sparsas nec methodo revinctas sententias, conjicere solebant; neque se artem universam complecti simulabant aut profitebantur. At eo quo nunc res agitur modo, minime mirum est, si homines in iis ulteriora non quaerant, quae pro perfectis et numeris suis jampridem absolutis traduntur.

LXXXVII.

Etiam antiqua magnum existimationis et fidei incrementum acceperunt ex eorum vanitate et levitate, qui nova proposuerunt; praesertim in philosophiae naturalis parte activa et operativa[46]. Neque enim defuerunt homines vaniloqui et

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[45] On the advantages of the Aphoristic over the Methodic treatment of a science which is still in its growth, cp. De Augmentis, lib. vi. cap. 2 (E. and S., pp. 665–6), where Bacon is still fuller and more explicit than in this passage.

In speaking of the 'primi et antiquissimi veritatis inquisitores,' he is probably thinking of Hippocrates, who wrote in Aphorisms, as well as of the early Greek philosophers, whose wisdom was contained in γνῶμαι, sententiae, or maxims.

[46] For a violent invective against the moderns, and especially Paracelsus

phantastici, qui partim ex credulitate, partim ex impostura, genus humanum promissis onerarunt: vitae prolongationem, senectutis retardationem, dolorum levationem, naturalium defectuum reparationem, sensuum deceptiones, affectuum ligationes et incitationes, intellectualium facultatum illuminationes et exaltationes, substantiarum transmutationes, et motuum ad libitum roborationes et multiplicationes, aëris impressiones et alterationes, coelestium influentiarum deductiones et procurationes, rerum futurarum divinationes, remotarum repraesentationes, occultarum revelationes, et alia complura pollicitando et ostentando. Verum de istis largitoribus non multum aberraverit, qui istiusmodi judicium fecerit, tantum nimirum in doctrinis philosophiae inter horum vanitates et veras artes interesse, quantum inter res gestas Julii Caesaris, aut Alexandri Magni, et res gestas Amadicii ex Gallia[47], aut Arthuri ex Britannia, in historiae narrationibus intersit. Inveniuntur enim clarissimi illi imperatores revera majora gessisse, quam umbratiles isti heroes etiam fecisse fingantur; sed modis et viis scilicet actionum minime fabulosis et prodigiosis. Neque propterea aequum est verae memoriae fidem derogari, quod a fabulis illa quandoque laesa sit et violata. Sed interim minime mirum est, si propositionibus novis (praesertim cum mentione operum) magnum sit factum praejudicium per istos impostores, qui similia tentaverunt; cum vanitatis excessus et fastidium etiam nunc omnem in ejusmodi conatibus magnanimitatem destruxerit.

LXXXVIII.

At longe majora a pusillanimitate, et pensorum, quae humana industria sibi proposuit, parvitate et tenuitate, detrimenta in scientias invecta sunt. Et tamen (quod pessimum est) pusillanimitas ista non sine arrogantia et fastidio se offert.

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and the Chemists, see Temporis Partus Masculus, E. and S., vol. iii. p. 531, &c. The passage begins thus: 'Nec non cape comites perfunctoriam Neotericorum turbam. Heus nomenclator, suggere. Atqui respondet, ne dignos esse quorum nomina teneat.' The quacks of Bacon's day were generally to be found amongst the professors of Alchemy and Magic.

[47] See Hallam's Literature of Europe, part i. ch. 4. § 70.

Primum enim, omnium artium illa reperitur cautela jam facta familiaris, ut in qualibet arte authores artis suae infirmitatem in naturae calumniam vertant; et quod ars ipsorum non assequitur, id ex eadem arte impossibile in natura pronunciant. Neque certe damnari potest ars, si ipsa judicet. Etiam philosophia, quae nunc in manibus est, in sinu suo posita quaedam fovet, aut placita, quibus (si diligentius inquiratur) hoc hominibus omnino persuaderi volunt; nil ab arte, vel hominis opere, arduum, aut in naturam imperiosum et validum, expectari debere; ut de heterogenia caloris astri et ignis, et mistione, superius dictum est[48]. Quae si notentur accuratius, omnino pertinent ad humanae potestatis circumscriptionem malitiosam, et ad quaesitam et artificiosam desperationem, quae non solum spei auguria turbet, sed etiam omnes industriae stimulos et nervos incidat, atque ipsius experientiae aleas abjiciat; dum de hoc tantum solliciti sint, ut ars eorum perfecta censeatur; gloriae vanissimae et perditissimae dantes operam, scilicet ut quicquid adhuc inventum et comprehensum non sit, id omnino nec inveniri, nec comprehendi posse in futurum credatur. At si quis rebus addere se[49] et novum aliquid reperire conetur, ille tamen omnino sibi proponet et destinabit unum aliquod inventum (nec ultra) perscrutari et eruere; ut magnetis naturam, maris fluxum et refluxum, thema coeli, et hujusmodi, quae secreti aliquid habere videntur, et hactenus parum feliciter tractata sint: quum summae sit imperitiae, rei alicujus naturam in se ipsa perscrutari; quandoquidem eadem natura, quae in aliis videtur latens et occulta, in aliis manifesta sit et quasi palpabilis, atque in illis admirationem, in his ne attentionem quidem moveat[50]; ut fit in natura consistentiae, quae in ligno vel lapide non notatur, sed solidi appellatione transmittitur, neque amplius de fuga separationis aut solutionis continuitatis

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[48] Aph. 75.

[49] Mr. Spedding quotes from the Redargutio Philosophiarum: 'Quare missis istis philosophiis abstractis, vos et ego, filii, rebus ipsis nos adjungamus.'

[50] On Ostensive or Glaring, and their opposite or Clandestine Instances, see Bk. ii. Aphs. 24, 25, and Herschel's Discourse on the Study of Natural Philosophy, §§ 192–3.

inquiritur; at in aquarum bullis eadem res videtur subtilis et ingeniosa; quae bullae se conjiciunt in pelliculas quasdam, in hemisphaerii formam curiose effictas, ut ad momentum temporis evitetur solutio continuitatis.

Atque prorsus illa ipsa, quae habentur pro secretis, in aliis habent naturam manifestam et communem; quae nunquam se dabit conspiciendam, si hominum experimenta aut contemplationes in illis ipsis tantum versentur. Generaliter autem et vulgo, in operibus mechanicis habentur pro novis inventis, si quis jampridem inventa subtilius poliat, vel ornet elegantius, vel simul uniat et componat, vel cum usu commodius copulet, aut opus majore, aut etiam minore, quam fieri consuevit, mole vel volumine exhibeat, et similia.

Itaque minime mirum est, si nobilia et genere humano digna inventa in lucem extracta non sint, quum homines hujusmodi exiguis pensis et puerilibus contenti et delectati fuerint; quinetiam in iisdem se magnum aliquod sequutos, aut assequutos putaverint.

LXXXIX.

Neque illud praetermittendum est, quod nacta sit philosophia naturalis per omnes aetates adversarium molestum et difficilem; superstitionem nimirum, et zelum religionis caecum et immoderatum[51]. Etenim videre est apud Graecos, eos, qui primum causas naturales fulminis et tempestatum insuetis adhuc hominum auribus proposuerunt, impietatis in deos eo nomine damnatos[52]: nec multo melius a nonnullis antiquorum

[51] Cp. Aph. 65. The notes on that Aphorism will also serve to illustrate this.

Though Bacon repudiated so vehemently the introduction of religious considerations into natural philosophy, there are many instances in his works of his deeply religious spirit. On his religious opinions generally, see Introduction, § 7.

[52] See Aristophanes' Clouds, l. 372, &c.:

ΣΤ. *νὴ τὸν Ἀπόλλω, τοῦτό γέ τοι δὴ τῷ νῦν λόγῳ εὖ προσέφυσας·*
καίτοι πρότερον τὸν Δί' ἀληθῶς ᾤμην διὰ κοσκίνου οὐρεῖν.
ἀλλ' ὅστις ὁ βροντῶν ἐστι φράσον· τοῦτό με ποιεῖ τετρεμαίνειν.
ΣΩ. *αὗται βροντῶσι κυλινδόμεναι.*
ΣΤ. *τῷ τρόπῳ, ὦ πάντα σὺ τολμῶν;*
ΣΩ. *ὅταν ἐμπλησθῶσ' ὕδατος πολλοῦ κἀναγκασθῶσι φέρεσθαι,*
κατακρημνάμεναι πλήρεις ὄμβρου δι' ἀνάγκην, εἶτα βαρεῖαι
εἰς ἀλλήλας ἐμπίπτουσαι ῥήγνυνται καὶ παταγοῦσιν.

patrum religionis Christianae exceptos fuisse eos, qui ex certissimis demonstrationibus (quibus nemo hodie sanus contradixerit) terram rotundam esse posuerunt, atque ex consequenti antipodas esse asseruerunt[53].

ΣΤ. *ὁ δ' ἀναγκάζων ἐστὶ τίς αὐτάς, οὐχ ὁ Ζεύς, ὥστε φέρεσθαι;*
ΣΩ. *ἥκιστ', ἀλλ' αἰθέριος δῖνος.*
ΣΤ. *Δῖνος; τουτί μ' ἐλελήθη,*
ὁ Ζεὺς οὐκ ὤν, ἀλλ' ἀντ' αὐτοῦ Δῖνος νυνὶ βασιλεύων.

One of the articles in the indictment against Socrates was that he did not 'worship the Gods whom the city worships.'

[53] Cp. Campanella, Metaph. lib. i. Proem.: 'S. Augustinus et Lactantius negant esse Antipodas, quoniam ignorant Mathematicam, et vulgus solem putat esse pedalem,' &c. See Lactantius, Divinae Institutiones, lib. iii. cap. 24: 'Quid illi, qui esse contrarios vestigiis nostris Antipodas putant; num aliquid loquuntur? aut est quisquam tam ineptus, qui credat esse homines, quorum vestigia sint superiora quam capita? aut ibi quae apud nos jacent, inversa pendere? fruges et arbores deorsum versus crescere? pluvias, et nives, et grandinem sursum versus cadere in terram? Et miratur aliquis hortos pensiles inter septem mira narrari; cum philosophi et agros, et maria, et urbes, et montes pensiles faciant?' He next proceeds to account for this strange opinion and that of the rotundity of the earth by what appeared to him false inferences from the motion of the stars, and then continues: 'Quod si quaeras ab iis, qui haec portenta defendunt, quomodo non cadunt omnia in inferiorem illam coeli partem: respondent, hanc rerum esse naturam, ut pondera in medium ferantur; et ad medium connexa sunt omnia, sicut radios videmus in rota: quae autem levia sunt, ut nebula, fumus, ignis, a medio deferantur, ut coelum petant.' St. Augustine (De Civitate Dei, lib. xvi. cap. 9) argues that, even if the world be round, it does not follow that there is land on the other side, or, even if there be such land, that it is inhabited. He then absolutely rejects the supposition of Antipodes ('nulla ratione credendum est') on the ground that it is inconsistent with the Scriptural account of the origin of the human race. 'Quoniam nullo modo Scriptura ista mentitur, quae narratis praeteritis facit fidem, eo quod ejus praedicta complentur: nimisque absurdum est, ut dicatur, aliquos homines ex hac in illam partem, Oceani immensitate trajecta, navigare ac pervenire potuisse, ut etiam illis ex uno illo primo homine genus institueretur humanum.'

The following quotation from one of Jeremy Taylor's Sermons (Heber's Edition, revised by Eden, vol. viii. p. 536) is so appropriate, and, moreover, so interesting in itself, that I cannot refrain from adding it: 'If any man have a revelation or a discovery of which thou knowest nothing but by his preaching, be not too quick to condemn it; not only lest thou discourage his labour and stricter enquiries in the search of truth, but lest thou also be a fool upon record; for so is every man that hastily judges what he slowly understands. Is it not a monument of a lasting reproach, that one of the popes of Rome condemned the bishop of Salzburg for saying that

Quinetiam, ut nunc sunt res, conditio sermonum de natura facta est durior et magis cum periculo, propter theologorum scholasticorum summas et methodos; qui cum theologiam (satis pro potestate) in ordinem redegerint, et in artis formam effinxerint, hoc insuper effecerunt, ut pugnax et spinosa Aristotelis philosophia[54] corpori religionis, plus quam par erat, immisceretur.

Eodem etiam spectant (licet diverso modo) eorum commentationes, qui veritatem Christianae religionis ex principiis ex authoritatibus philosophorum deducere et confirmare haud veriti sunt; fidei et sensus conjugium tanquam legitimum multa pompa et solennitate celebrantes, et grata rerum varietate animos hominum permulcentes; sed interim divina humanis, impari conditione, permiscentes. At in hujusmodi misturis theologiae cum philosophia, ea tantum, quae nunc in

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there were *antipodes*? and is not pope Nicholas deserted by his own party for correcting the sermons of Berengarius, and making him recant into a worse error? and posterity will certainly make themselves very merry with the wise sentences made lately at Rome against Galileo and the Jansenists. To condemn one truth is more shameful than to broach two errors: for he that in an honest and diligent enquiry misses something of the mark, will have the apologies of human infirmity, and the praise of doing his best; but he that condemns a truth when it is told him, is an envious fool, and is a murderer of his brother's fame, and his brother's reason.'

Mr. Mill discusses the incapacity of conceiving the existence of Antipodes in two places of his Logic, namely, bk. ii. ch. 5. § 6, and bk. v. ch. 3. § 3. It is, perhaps, superfluous to remark, with reference to these passages, that Mr. Mill's views as to the relation of inconceivability to impossibility are combated by Mr. Herbert Spencer.

[54] In the corresponding passage of the Cogitata et Visa (E. and S., p. 596), he says: 'hoc insuper ausi sunt, ut contentiosam et tumultuariam Aristotelis philosophiam corpori religionis inseruerint.'

It has often been remarked that the distinguishing characteristic of the scholastic theology was the union of theological matter with a dialectical form, the theological matter being derived from the Scriptures and the Fathers, and the dialectical form from the Logic of Aristotle. But with the form, no inconsiderable portion of the matter of the Aristotelian philosophy, especially in the domains of psychology and metaphysics, frequently effected an entrance, and thus, to a certain extent, determined both the terminology and the doctrines of the Mediaeval Church. In illustration of this statement, see Bishop Hampden's Bampton Lectures, a work which well deserves the attention both of the theological and the philosophical student.

philosophia recepta sunt, comprehenduntur; sed nova, licet in melius mutata, tantum non summoventur et exterminantur [55].

Denique invenias, ex quorundam theologorum imperitia, aditum alicui philosophiae, quamvis emendatae, pene interclusum esse. Alii siquidem simplicius subverentur, ne forte altior in naturam inquisitio ultra concessum sobrietatis terminum penetret; traducentes et perperam torquentes ea, quae de divinis mysteriis in Scripturis sacris adversus rimantes secreta divina dicuntur, ad occulta naturae, quae nullo interdicto prohibentur. Alii callidius conjiciunt et animo versant, si media ignorentur, singula ad manum et virgulam divinam (quod religionis, ut putant, maxime intersit) facilius posse referri: quod nihil aliud est, quam *Deo per mendacium gratificari* [56] velle. Alii ab exemplo metuunt, ne motus et mutationes circa philosophiam in religionem incurrant ac desinant.

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[55] This is one of Bacon's shrewdest remarks. It is abundantly illustrated in the history of science both before and since his time. A new discovery in science is at first decried as contrary or even fatal to faith; then, after a time, it is grudgingly admitted, and incorporated into the received doctrine, till at last no one dreams of calling it in question. But the process soon begins afresh with some more recent discovery, so that a constant warfare is going on between the unwise theologian and the scientific investigator. And this warfare is wholly unnecessary, and can have only one issue. For the scientific theory must ultimately stand or fall on scientific grounds, and, should it be ultimately admitted, the theologian, whether he acquiesces in the result or not, must, with the rest of mankind, bow to the decision of competent judges. No thoughtful man, of course, can avoid comparing the results of science with his religious beliefs, but the results of science, to be worth anything at all, must be arrived at by a purely independent process, employing only scientific data and submitting only to scientific tests. The man of science has a right to demand that his investigations shall not be hampered by theological prepossessions; but the results at which he arrives become the common property of all, and it is for the theologian to co-ordinate these results with his religious beliefs, or, if need be, to adapt his religious beliefs to the new facts or newly established generalisations which are presented to him.

[56] Cp. De Augmentis, lib. i. (E. and S., vol. i. p. 436): 'Namque eos qui autumant nimiam scientiam inclinare mentem in atheismum, ignorantiamque secundarum causarum pietati erga primam obstetricari libenter compellarem Jobi quaestione, *An oporteat mentiri pro Deo, et ejus gratia dolum loqui conveniat, ut ipsi gratificemur?*' The passage in Job, here referred to, is ch. xiii. ver. 7.

Alii denique solliciti videntur, ne in naturae inquisitione aliquid inveniri possit, quod religionem (praesertim apud indoctos) subvertat, aut saltem labefactet. At isti duo posteriores metus nobis videntur omnino sapientiam animalem sapere; ac si homines, in mentis suae recessibus et secretis cogitationibus, de firmitudine religionis, et fidei in sensum imperio diffiderent ac dubitarent; et propterea ab inquisitione veritatis in naturalibus periculum illis impendere metuerent. At vere rem reputanti, philosophia naturalis, post verbum Dei, certissima superstitionis medicina est; eademque probatissimum fidei alimentum. Itaque merito religioni donatur tanquam fidissima ancilla: cum altera voluntatem Dei, altera potestatem manifestet[57]. Neque enim erravit Ille, qui dixit; *erratis, nescientes Scripturas et potestatem Dei*[58]*:* informationem de voluntate et meditationem de potestate nexu individuo commiscens et copulans. Interim minus mirum est, si naturalis philosophiae incrementa cohibita sint; cum religio, quae plurimum apud animos hominum pollet, per quorundam imperitiam et zelum incautum in partem contrariam transierit et abrepta fuerit.

XC.

Rursus in moribus et institutis scholarum, academiarum, collegiorum, et similium conventuum, quae doctorum hominum sedibus et eruditionis culturae destinata sunt, omnia progressui scientiarum adversa inveniuntur[59]. Lectiones enim et

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[57] In the Advancement of Learning (E. and S., vol. iii. p. 478) and in the Ninth Book of the De Augmentis, it is the *glory* of God, as revealed by Nature, which is opposed to the *will* of God, as revealed by Scripture. 'Wherefore we conclude that sacred Theology (which in our idiom we call Divinity) is grounded only upon the word and oracle of God, and not upon the light of nature: for it is written, Coeli enarrant gloriam Dei, but it is not written, Coeli enarrant voluntatem Dei, but of that it is said, Ad legem et testimonium.'

[58] Matt. xxii. 29.

[59] The main business of the Universities at this time was the 'disputations.' Their chief interests were either literary or theological, and, so far as the physical sciences were cultivated at all, it was, at least in the English Universities, mainly in the old tracks. As late as the foundation of Sir William Sedley's Professorship of Natural Philosophy in 1621, it was prescribed that the Professor should lecture in the works of Aristotle.

exercitia ita sunt disposita, ut aliud a consuetis haud facile cuiquam in mentem veniat cogitare aut contemplari. Si vero unus aut alter fortasse judicii libertate uti sustinuerit, is sibi soli hanc operam imponere possit; ab aliorum autem consortio nihil capiet utilitatis. Sin et hoc toleraverit, tamen in capessenda fortuna industriam hanc et magnanimitatem sibi non levi impedimento fore experietur. Studia enim hominum in ejusmodi locis in quorundam authorum scripta, veluti in carceres, conclusa sunt; a quibus si quis dissentiat, continuo ut homo turbidus et rerum novarum cupidus corripitur. At magnum certe discrimen inter res civiles et artes: non enim idem periculum a novo motu et a nova luce. Verum in rebus civilibus mutatio etiam in melius suspecta est ob perturbationem; cum civilia authoritate, consensu, fama, et opinione, non demonstratione[60], nitantur. In artibus autem et scientiis,

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In the statute regulating the duties of the Chair, there is not a hint of any independent treatment of the subject. The statutes of the Savilian Professor of Astronomy, however, which date from 1619, direct the Professor, on occasion, to refer to the theories or discoveries of recent writers: 'Astronomiae Professor ad suum munus sciat necessario pertinere interpretationem totius Mathematicae Constructionis Ptolemaei (Almagestum vocant), adhibitis, suo loco, Copernici, Gebri, et aliorum Recentiorum inventis.'

Bacon pursues this complaint at greater length in the Introduction to the Second Book of the De Augmentis (E. and S., vol. i. pp. 487–492). His own idea of an institution for the advancement of science is given in the New Atlantis.

The letters written by Bacon to the Universities of Oxford and Cambridge, and to Trinity College, Cambridge, on sending them copies of his works, are interesting in connection with this Aphorism. The following is the letter inscribed in the copy of the De Augmentis, sent to the University of Oxford:

'Franciscus Baro de Verulamio, Vicecomes S^ti^ Albani, inclytae Academiae Oxoniensi S.

Cum Almae matri meae incl. Academiae Cantabrigiensi scripserim, deessem sane officio, si simile amoris pignus sorori ejus non deferrem. Sicut autem eos hortatus sum, ita et vos hortor; ut Scientiarum Augmentis strenue incumbatis, et veterum labores neque nihil neque omnia esse putetis, sed vires etiam proprias modeste perpendentes, subinde tamen experiamini. Omnia cedent quam optime, si arma non alii in alios vertatis, sed junctis copiis in Naturam rerum impressionem faciatis. Sufficiet quippe illa honori et victoriae. Valete.'

[60] This is not inconsistent with what Bacon says in Aph. 127, where

tanquam in metalli fodinis, omnia novis operibus et ulterioribus progressibus circumstrepere debent. Atque secundum rectam rationem res ita se habet, sed interim non ita vivitur: sed ista, quam diximus, doctrinarum administratio et politia scientiarum augmenta durius premere consuevit.

XCI.

Atque insuper licet ista invidia cessaverit; tamen satis est ad cohibendum augmentum scientiarum, quod hujusmodi conatus et industriae praemiis careant. Non enim penes eosdem est cultura scientiarum et praemium. Scientiarum enim augmenta a magnis utique ingeniis proveniunt; at pretia et praemia scientiarum sunt penes vulgus aut principes viros, qui (nisi raro admodum) vix mediocriter docti sunt. Quinetiam hujusmodi progressus non solum praemiis et beneficentia hominum, verum etiam ipsa populari laude destituti sunt. Sunt enim illi supra captum maximae partis hominum, et ab opinionum vulgarium ventis facile obruuntur et extinguuntur. Itaque nil mirum, si res illa non foeliciter successerit, quae in honore non fuit.

XCII.

Sed longe maximum progressibus scientiarum, et novis pensis ac provinciis in iisdem suscipiendis, obstaculum deprehenditur in desperatione hominum, et suppositione impossibilis. Solent enim viri prudentes et severi in hujusmodi rebus plane diffidere: naturae obscuritatem, vitae brevitatem, sensuum fallacias, judicii infirmitatem, experimentorum difficultates, et similia secum reputantes. Itaque existimant, esse quosdam scientiarum, per temporum et aetatum mundi revolutiones, fluxus et refluxus; cum aliis temporibus crescant et floreant, aliis declinent et jaceant: ita tamen, ut cum ad certum quendam gradum et statum pervenerint, nil ulterius possint [61].

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he appears to contemplate the possibility of a political science, established by induction. All that he means here is that the stability of a government depends not on the reasons which can be assigned in its favour, but on authority, usage, assent, &c.

[61] On the idea of Cycles, as applied to the phenomena of human society, see Mill's Logic, bk. vi. ch. 10. § 3. For the celebrated cycle of Plato, see

Itaque si quis majora credat aut spondeat, id putant esse cujusdam impotentis et immaturi animi; atque hujusmodi conatus initia scilicet laeta, media ardua, extrema confusa habere. Atque cum hujusmodi cogitationes eae sint, quae in viros graves et judicio praestantes facile cadant, curandum revera est, ne rei optimae et pulcherrimae amore capti severitatem judicii relaxemus, aut minuamus; et sedulo videndum, quid spei affulgeat, et ex qua parte se ostendat; atque auris levioribus spei rejectis, eae, quae plus firmitudinis habere videntur, omnino discutiendae sunt et pensitandae. Quinetiam prudentia civilis ad consilium vocanda est et adhibenda, quae ex praescripto diffidit, et de rebus humanis in deterius conjicit. Itaque jam et de spe dicendum est; praesertim cum nos promissores non simus, nec vim aut insidias hominum judiciis faciamus aut struamus, sed homines manu et sponte ducamus. Atque licet longe potentissimum futurum sit remedium ad spem imprimendam, quando homines ad particularia, praesertim in tabulis nostris inveniendi digesta et disposita (quae partim ad secundam, sed multo magis ad quartam *Instaurationis* [62] nostrae partem pertinent), adducemus; cum hoc ipsum sit non spes tantum, sed tanquam res ipsa: tamen ut omnia clementius fiant, pergendum est in instituto nostro de praeparandis hominum mentibus; cujus praeparationis ista ostensio spei pars est non exigua. Nam absque ea, reliqua faciunt magis ad contristationem hominum (scilicet, ut deteriorem et viliorem habeant de iis, quae jam in usu sunt, opinionem, quam nunc habent, et suae conditionis infortunium plus sentiant et pernoscant), quam ad alacritatem

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the beginning of the eighth book of the Republic, and for Aristotle's criticism on it, Politics, viii. (v.) 12. The idea of cycles and of periodical crises, at which the accumulated property, inventions, institutions, &c. of mankind are swept away, is to be found also in the third book of the Laws.

[62] The fourth part of the Instauration was to be the Scala Intellectus, the second is, of course, the Novum Organum. For Bacon's conception of the fourth part, see the Distributio Operis, pp. 174, 175. At the end of his account, he says: 'Itaque hujusmodi exemplis' (namely, such as shall present the whole process of discovery) 'quartam partem nostri operis attribuimus: quae revera nil aliud est, quam secundae partis applicatio particularis et explicata.'

aliquam inducendam, aut industriam experiendi acuendam. Itaque conjecturae nostrae, quae spem in hac re faciunt probabilem, aperiendae sunt et proponendae: sicut Columbus fecit [63], ante navigationem illam suam mirabilem maris Atlantici: cum rationes adduxerit, cur ipse novas terras et continentes praeter eas, quae ante cognitae fuerunt, inveniri posse confideret: quae rationes, licet primo rejectae, postea tamen experimento probatae sunt, et rerum maximarum causae et initia fuerunt.

XCIII.

Principium autem [64] sumendum a Deo: hoc nimirum quod agitur, propter excellentem in ipso boni naturam, manifeste a Deo esse, qui author boni, et pater luminum est. In operationibus autem divinis, initia quaeque tenuissima exitum certo trahunt. Atque quod de spiritualibus dictum est, *Regnum Dei non venit cum observatione* [65], id etiam in omni majore opere Providentiae evenire reperitur; ut omnia sine strepitu et sonitu placide labantur, atque res plane agatur priusquam homines eam agi putent aut advertant. Neque omittenda est prophetia Danielis de ultimis mundi temporibus; *Multi pertransibunt, et multiplex erit scientia* [66]: manifeste innuens et significans, esse in fatis, id est, in Providentia, ut pertransitus mundi (qui per tot longinquas navigationes impletus plane aut jam in opere esse videtur) et augmenta scientiarum in eandem aetatem incidant.

XCIV.

Sequitur ratio omnium maxima ad faciendam spem; nempe

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[63] For many years before Columbus was enabled to start on his voyage of discovery, it had become a fixed idea in his mind that land was to be found to the West. For the reasons of this belief, depending partly on general geographical considerations, partly on the stories of mariners, partly on the fact that pieces of pine, cane, and the like, had been found washed ashore on the coast of Portugal, the Azores, &c., see Washington Irving's Life and Voyages of Columbus, ch. 3.

[64] Here begins the enumeration of the Grounds of Hope, which are twenty-one in all. The enumeration is completed in the 114th Aphorism.

[65] Luke xvii. 20.

[66] Daniel xii. 4. This text forms the motto to the frontispiece prefixed to the First Edition of the Novum Organum.

ex erroribus temporis praeteriti et viarum adhuc tentatarum. Optima enim est ea reprehensio, quam de statu civili haud prudenter administrato quispiam his verbis complexus est [67]: *Quod ad praeterita pessimum est, id ad futura optimum videri debet. Si enim vos omnia, quae ad officium vestrum spectant, praestitissetis, neque tamen res vestrae in meliore loco essent; ne spes quidem ulla reliqua foret, eas in melius provehi posse. Sed cum rerum vestrarum status, non a vi ipsa rerum, sed ab erroribus vestris male se habeat; sperandum est, illis erroribus missis aut correctis, magnam rerum in melius mutationem fieri posse.* Simili modo, si homines per tanta annorum spatia viam veram inveniendi et colendi scientias tenuissent, nec tamen ulterius progredi potuissent; audax proculdubio et temeraria foret opinio, posse rem in ulterius provehi. Quod si in via ipsa erratum sit, atque hominum opera in iis consumpta, in quibus minime oportebat; sequitur ex eo, non in rebus ipsis difficultatem oriri, quae potestatis nostrae non sunt, sed in intellectu humano ejusque usu et applicatione; quae res remedium et medicinam suscipit. Itaque optimum fuerit illos ipsos errores proponere: quot enim fuerint errorum impedimenta in praeterito, tot sunt spei argumenta in futurum. Ea vero licet in his, quae superius dicta sunt, non intacta omnino fuerint; tamen ea etiam nunc breviter, verbis nudis ac simplicibus, repraesentare visum est.

XCV.

Qui tractaverunt scientias aut empirici aut dogmatici [68] fuerunt. Empirici, formicae more, congerunt tantum, et utuntur: rationales, aranearum more, telas ex se conficiunt: apis vero ratio media est, quae materiam ex floribus horti et agri elicit; sed tamen eam propria facultate vertit et digerit. Neque absimile philosophiae verum opificium est; quod nec mentis viribus tantum aut praecipue nititur, neque ex historia naturali et mechanicis experimentis praebitam

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[67] Demosth. Phil. iii. pp. 111, 112. Cp. Phil. i. p. 40.

[68] See the Preface to the Novum Organum, and Aphs. 62, 64, 67.

This is one of the best known, and most happily expressed, of Bacon's Aphorisms. But, after the explanations already given, it does not appear to require any annotation. The last sentence shews how far Bacon was from recommending a merely empirical philosophy.

materiam, in memoria integram, sed in intellectu mutatam et subactam, reponit. Itaque ex harum facultatum (experimentalis scilicet et rationalis) arctiore et sanctiore foedere (quod adhuc factum non est) bene sperandum est.

XCVI.

Naturalis philosophia adhuc sincera non invenitur, sed infecta et corrupta: in Aristotelis schola, per logicam[69], in Platonis schola, per theologiam naturalem[70]; in secunda schola[71] Platonis, Procli, et aliorum, per mathematicam; quae philosophiam naturalem terminare, non generare aut procreare debet[72]. At ex philosophia naturali pura et impermista meliora speranda sunt.

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[69] See Aphs. 54, 63, with my notes on them.

[70] See Aph. 65, with my notes. Cp. also Aph. 48, so far as it bears on Final Causes.

[71] Bacon is alluding to the Neoplatonists, though, properly speaking, the 'secunda schola Platonis' is the New Academy. On the philosophy of the Neoplatonists, see Zeller or Ueberweg. The slightest knowledge of their system will shew the justice of Bacon's criticism.

[72] Cp. De Augmentis, lib. iii. cap. 6, which the student should read carefully in connection with this Aphorism. I am inclined to think that Bacon had conceived, though, perhaps, not very clearly, the true relation between Physics and Mathematics. The most general axioms of Natural Philosophy were to be carefully established by induction; then, when they had been stated in a quantitative form, they were to be combined with each other, and worked out deductively, by means of mathematical calculations, into all their ramifications and applications. It is needless to add that the magnificent achievements of modern science (witness, for instance, the Principia or Optics of Newton, or the Mécanique Analytique of Lagrange) have been due at least as much to mathematical calculation as to inductive generalisation. The more advanced sciences, in fact, become, in their later stages, mainly mathematical. But, while a science remains in its earlier, or inductive, stage, it is only capable of mathematical treatment, if at all, to a very slight degree. This, for instance, is still the case with the sciences of chemistry and physiology.

The parallel passage in Bk. ii. Aph. 8 ('Optime autem cedit inquisitio naturalis, quando physicum terminatur in mathematico'), appears to apply specially to the enumeration and mensuration of the ultimate particles of matter, as conceived by Bacon. Hence, it might be contended that his view of the functions of Mathematics in the present Aphorism is equally limited. But I am inclined to think that here the remark has a much wider bearing, and that the office of Mathematics, as contemplated in ii. 8, would be only a special exemplification of the functions here ascribed to them.

XCVII.

Nemo adhuc tanta mentis constantia et rigore inventus est, ut decreverit et sibi imposuerit theorias et notiones communes penitus abolere, et intellectum abrasum et aequum ad particularia de integro applicare[73]. Itaque ratio illa humana, quam habemus, ex multa fide, et multo etiam casu, nec non ex puerilibus, quas primo hausimus, notionibus, farrago quaedam est et congeries.

Quod si quis aetate matura, et sensibus integris, et mente repurgata, se ad experientiam et ad particularia de integro applicet, de eo melius sperandum est. Atque hac in parte nobis spondemus fortunam Alexandri Magni: neque quis nos vanitatis arguat, antequam exitum rei audiat, quae ad exuendam omnem vanitatem spectat.

Etenim de Alexandro et ejus rebus gestis Aeschines ita loquutus est: *Nos certe vitam mortalem non vivimus; sed in hoc nati sumus, ut posteritas de nobis portenta narret et praedicet*[74]*:* perinde ac si Alexandri res gestas pro miraculo habuisset.

At aevis sequentibus Titus Livius melius rem advertit et introspexit, atque de Alexandro hujusmodi quippiam dixit[75]:

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[73] This reminds us of Descartes, who may possibly have been influenced by reading this passage and the Aphorisms on the Idola. For an account of the process by which he attempted to clear his mind of preconceived notions, see the First Meditation, or the beginning of the First Part of the Principia, or the earlier portion of the Dissertatio de Methodo. The completeness with which he attempted to carry out his purpose may be judged of by the following brief passage, taken from the De Methodo: 'Sed quod ad eas opiniones attinet, quas ego ipse in eum usque diem fueram amplexus, nihil melius facere me posse arbitrabar, quam si omnes simul et semel e mente mea delerem, ut deinde vel alias meliores vel certe easdem, sed postquam maturae rationis examen subiissent, admitterem: credebamque hoc pacto longe melius me ad vitam regendam posse informari, quam si veteris aedificii fundamenta retinerem, iisque tantum principiis inniterer, quibus olim juvenilis aetas mea, nullo unquam adhibito examine an veritati congruerent, credulitatem suam addixerat.'

[74] Aeschines in Ctesiphontem, p. 72. § 132: *Τοιγάρτοι τί τῶν ἀνελπίστων καὶ ἀπροσδοκήτων ἐφ' ἡμῶν οὐ γέγονεν; Οὐ γὰρ βίον γ' ἡμεῖς ἀνθρώπινον βεβιώκαμεν, ἀλλ' εἰς παραδοξολογίαν τοῖς ἐσομένοις μεθ' ἡμᾶς ἔφυμεν.*

[75] Livy, ix. 17 ad fin.

Eum non aliud quam bene ausum vana contemnere. Atque simile etiam de nobis judicium futuris temporibus factum iri existimamus: *Nos nil magni fecisse; sed tantum ea, quae pro magnis habentur, minoris fecisse.* Sed interim (quod jam diximus) non est spes nisi in *regeneratione* scientiarum; ut eae scilicet ab experientia certo ordine excitentur et rursus condantur: quod adhuc factum esse aut cogitatum nemo (ut arbitramur) affirmaverit.

XCVIII.

Atque experientiae fundamenta[76] (quando ad hanc omnino

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[76] This, the sixth, is one of the most important of the 'Grounds of Hope.' It is taken from the future construction of a Natural History, specially adapted to the wants of Natural Philosophy ('collecta ad informandum intellectum in ordine ad condendam philosophiam'), and containing a record of experiments as well as observations. This 'Natural History' was to be supplied in the third part of the Instauratio Magna, which was to be entitled 'Phaenomena Universi, sive Historia Naturalis et Experimentalis ad condendam Philosophiam.' Towards constructing this third part of the Instauratio several attempts were made by Bacon, as in the Historia Ventorum, Historia Vitae et Mortis, Historia Densi et Rari, Sylva Sylvarum, &c. These works are collected in the third volume of Ellis and Spedding's Edition, pp. 1–680. It must be confessed, however, of these pieces, that they answer but very imperfectly to Bacon's conception of a natural history as delineated in this Aphorism. Far the most successful, perhaps the only successful, part of Liebig's attack on Bacon is directed against this class of his writings.

On the supreme importance which Bacon attached to the collection of observations and experiments which it was his intention to make, see Mr. Spedding's Preface to the Parasceue, given in vol. i. of the Collected Works, pp. 369–390. I cannot, however, but think that Mr. Spedding slightly exaggerates the importance which Bacon attached to this part of his reform. Surely '*the* novelty, from which the most important results were to be expected,' if we are to select any one part of the scheme as such, was his Inductive Method. 'Spes est una in inductione vera.' 'In hac certe inductione' (namely, induction as reformed by himself) 'spes maxima sita est.'

It may be remarked, however, as a proof of the great importance which Bacon attached to his Natural History, that, when he published the Novum Organum in its fragmentary form, passing over all the 'auxilia intellectus' (see lib. ii. Aph. 21) between the first and eighth, he thought it desirable to append an account of the latter, as furnishing a description of the plan on which his Natural History was to be constructed. The title of this Appendix is 'Parasceue ad Historiam Naturalem et Experimentalem,' or 'Descriptio Historiae Naturalis et Experimentalis, Qualis sufficiat et sit in

deveniendum est) aut nulla, aut admodum infirma adhuc fuerunt; nec particularium sylva et materies, vel numero, vel genere, vel certitudine, informando intellectui competens, aut ullo modo sufficiens, adhuc quaesita est et congesta. Sed contra homines docti (supini sane et faciles) rumores quosdam experientiae, et quasi famas et auras ejus, ad philosophiam suam vel constituendam vel confirmandam exceperunt, atque illis nihilominus pondus legitimi testimonii attribuerunt. Ac veluti si regnum aliquod aut status non ex literis et relationibus a legatis et nuntiis fide dignis missis, sed ex urbanorum sermunculis et ex triviis consilia sua et negotia gubernaret; omnino talis in philosophiam administratio, quatenus ad experientiam, introducta est. Nil debitis modis exquisitum, nil verificatum, nil numeratum, nil appensum, nil dimensum in naturali historia reperitur[77]. At quod in observatione indefinitum et vagum, id in informatione fallax et infidum est. Quod si cui haec mira dictu videantur, et querelae minus justae propiora, cum Aristoteles tantus ipse vir, et tanti regis opibus subnixus, tam accuratam *de animalibus* historiam confecerit, atque alii nonnulli majore diligentia (licet strepitu minore) multa adjecerint, et rursus alii de plantis, de metallis, et fossilibus, historias et narrationes copiosas conscripserint; is sane non satis attendere et perspicere videtur, quid agatur in praesentia. Alia enim est ratio naturalis historiae, quae propter se confecta est; alia ejus, quae collecta est ad informandum intellectum in ordine ad condendam

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ordine ad Basin et Fundamenta Philosophiae Verae.' It is followed by a 'Catalogus Historiarum Particularium,' on which he designed, at his leisure, to draw up a list of questions, illustrating the true method of enquiry. We are informed, moreover, by Dr. Rawley that the Sylva Sylvarum was the last work on which Bacon was engaged. In that case, he must have suspended the composition of the Novum Organum, in order to carry on his Natural History.

[77] Cp. Parasceue, Aph. 7. On the necessity of accurately weighing, measuring, and counting in conducting observations or experiments, it is now needless to insist. The student will find a brief and excellent account of 'Methods of Observation' in Whewell's Novum Organum Renovatum, book iii. ch. 2. If he wishes to pursue the subject at greater length, he may read with advantage the Third Book of Professor Jevons' Principles of Science, entituled 'Methods of Measurement.'

philosophiam [78]. Atque hae duae historiae tum aliis rebus, tum praecipue in hoc differunt; quod prima ex illis specierum naturalium varietatem, non artium mechanicarum experimenta contineat. Quemadmodum enim in civilibus ingenium cujusque, et occultus animi affectuumque sensus, melius elicitur, cum quis in perturbatione ponitur, quam alias: simili modo, et occulta naturae magis se produnt per vexationes artium, quam cum cursu suo meant [79]. Itaque tum demum bene sperandum est de naturali philosophia, postquam historia naturalis (quae ejus basis est et fundamentum) melius instructa fuerit; antea vero minime.

XCIX.

Atque rursus in ipsa experimentorum mechanicorum copia, summa eorum, quae ad intellectus informationem maxime faciunt et juvant, detegitur inopia. Mechanicus enim, de veritatis inquisitione nullo modo sollicitus, non ad alia quam quae operi suo subserviunt aut animum erigit aut manum porrigit. Tum vero de scientiarum ulteriore progressu spes bene fundabitur, quum in Historiam Naturalem recipientur et aggregabuntur complura experimenta, quae in se nullius sunt usus, sed ad inventionem causarum et axiomatum tantum faciunt; quae nos *lucifera* experimenta, ad differentiam *fructiferorum*, appellare consuevimus [80]. Illa autem miram habent in se vir-

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[78] Bacon constantly insists on the subordination of Natural History to Natural Philosophy. But it is difficult to conceive any philosophical writer collecting natural facts for any other purpose than that of basing on them philosophical generalisations. Aristotle, certainly, is not chargeable with this fault.

It was not on any difference in the object for which they were collected, but on the number, variety, accuracy, and pertinency of the observations, and on the distinctive character of the inductive method which was to be applied to them, when collected, that Bacon should have insisted as distinguishing the Natural History which he designed to inaugurate from that of his predecessors.

[79] Nature best discovers her secrets, when tortured by Art. This is an excellent illustration of the advantage which Experiment, at least in many cases, possesses over Observation. For the differences between the two processes, see Mill's Logic, bk. iii. ch. 7, or my Inductive Logic, ch. 2. § 1.

[80] See Aph. 70, with note 78.

tutem et conditionem; hanc videlicet, quod nunquam fallant aut frustrentur. Cum enim ad hoc adhibeantur, non ut opus aliquod efficiant sed ut causam naturalem in aliquo revelent, quaquaversum cadunt, intentioni aeque satisfaciunt; cum quaestionem terminent.

C.

At non solum copia major experimentorum quaerenda est et procuranda, atque etiam alterius generis, quam adhuc factum est; sed etiam methodus[81] plane alia et ordo et processus continuandae et provehendae Experientiae introducenda. Vaga enim Experientia et se tantum sequens (ut superius dictum est[82]) mera palpatio est, et homines potius stupefacit quam informat. At cum Experientia lege certa procedet, seriatim et continenter, de scientiis aliquid melius sperari poterit.

CI.

Postquam vero copia et materies Historiae Naturalis et Experientiae, talis qualis ad opus intellectus sive ad opus philosophicum requiritur, praesto jam sit et parata; tamen nullo modo sufficit intellectus, ut in illam materiem agat sponte et memoriter; non magis, quam si quis computationem alicujus ephemeridis memoriter se tenere et superare posse speret. Atque hactenus tamen potiores meditationis partes quam scriptionis in inveniendo fuerunt; neque adhuc Experientia literata[83] facta est: atqui nulla nisi de scripto inventio probanda est. Illa vero in usum inveniente, ab Experientia facta demum literata melius sperandum.

CII.

Atque insuper cum tantus sit particularium numerus et quasi exercitus, isque ita sparsus et diffusus, ut intellectum disgreget

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[81] What follows is a mere repetition of what has already been said in the preceding Aphorisms.

[82] Aph. 82.

[83] He is speaking here of experience, that is, observations and experiments, committed to writing. But in Aphs. 103, 110, the expression 'experientia literata' is used in the same sense as in the passage already quoted from the De Augmentis, lib. v. cap. 2, namely, to denote a method of consulting experience intermediate between 'mera palpatio' and the 'novum organum.' See note 74 on Aph. 70.

et confundat, de velitationibus et levibus motibus et transcursibus intellectus non bene sperandum est; nisi fiat instructio et coordinatio, per tabulas inveniendi[84] idoneas et bene dispositas et tanquam vivas, eorum quae pertinent ad subjectum in quo versatur inquisitio, atque ad harum tabularum auxilia praeparata et digesta mens applicetur.

CIII.

Verum post copiam particularium rite et ordine veluti sub oculos positorum, non statim transeundum est ad inquisitionem et inventionem novorum particularium aut operum; aut saltem, si hoc fiat, in eo non acquiescendum. Neque enim negamus, postquam omnia omnium artium experimenta collecta et digesta fuerint atque ad unius hominis notitiam et judicium pervenerint, quin ex ipsa traductione experimentorum unius artis in alias multa nova inveniri possint ad humanam vitam et statum utilia, per istam Experientiam quam vocamus Literatam[85]: sed tamen minora de ea speranda sunt; majora vero a nova luce Axiomatum[86] ex particularibus illis certa via et regula eductorum, quae rursus nova particularia indicent et designent. Neque enim in plano via sita est[87], sed ascendendo et descendendo; ascendendo primo ad Axiomata, descendendo ad Opera.

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[84] He is alluding to Tables, such as those which are given in the early part of the Second Book.

[85] See note 83 on Aph. 101. We must recollect that the distinction between 'Experientia Literata' and 'Interpretatio Naturae sive Novum Organum' is that the former proceeds 'ab experimentis ad experimenta,' the latter 'ab experimentis ad axiomata, quae et ipsa nova experimenta designent.' For a full account of Experientia Literata and the various modes of experimenting which it includes, see the long passage at the end of De Augmentis, lib. ii. cap. 5 (E. and S., vol. i. pp. 622–633). Of the various modes of experimenting, Traductio or Translatio is only one, and the 'traductio experimentorum unius artis in alias,' again, is only one variety of this. The student will find the passage in the De Augmentis above referred to, notwithstanding its length, of great interest.

[86] Cp. De Augmentis, l. c.: 'Nam lumen ipsum ab Interpretatione Naturae, sive Novo Organo, petendum est.'

[87] Examples of the upward process were to be given in the Scala Intellectus, or fourth part of the Instauratio Magna, while the downward process, or application to practice, was reserved for the sixth and last part.

CIV.

Neque tamen permittendum est, ut intellectus a particularibus ad axiomata remota et quasi generalissima (qualia sunt principia, quae vocant, artium et rerum) saliat et volet; et ad eorum immotam veritatem axiomata media probet et expediat[88]: quod adhuc factum est, prono ad hoc impetu naturali intellectus, atque etiam ad hoc ipsum, per demonstrationes quae fiunt per syllogismum, jampridem edocto et assuefacto[89]. Sed de scientiis tum demum bene sperandum est, quando per scalam veram, et per gradus continuos et non intermissos aut hiulcos, a particularibus ascendetur ad axiomata minora, et deinde ad media, alia aliis superiora, et postremo demum ad generalissima. Etenim axiomata infima non multum ab experientia nuda discrepant. Suprema vero illa et generalissima (quae habentur) notionalia[90] sunt et abstracta, et nil habent solidi. At media sunt axiomata illa vera et solida et viva, in quibus humanae res et fortunae sitae sunt[91]; et supra haec quoque, tandem ipsa illa generalissima; talia scilicet quae non abstracta sint, sed per haec media vere limitantur[92].

Itaque hominum intellectui non plumae addendae, sed plumbum potius et pondera[93]; ut cohibeant omnem saltum

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[88] Cp. Aph. 19 and note 22.

[89] Cp. Aph. 20.

[90] That is, founded in the notions of the human mind, instead of in the realities of nature.

[91] Cp. the last paragraph of Aph. 66, and note 55.

[92] That is, such as may be shown to include the axiomata media, laws, in fact, of which the axiomata media are particular cases, admitting of verification. The laws of motion, as now stated, or the law of gravity, or the law of definite proportions in Chemistry, would be instances of the kind of 'axiomata generalissima' which Bacon had in view. With them we may compare such 'abstract and notional' first principles, as 'Every body seeks its own place,' or 'The celestial motions are circular,' or 'Nature does nothing in vain.' It was not the generality of the old 'axiomata generalissima,' but their vagueness and the slight extent to which they rested on ascertained facts, and the unwillingness of men to submit them to verification, which caused them to be so serious an obstacle to the advance of science. No laws, of which we can at present form any conception, can be more general than the Laws of Motion, but, at the same time, no generalisations can be more precisely stated, and none can rest on a wider basis of evidence or account for a larger number of facts.

[93] The truth is that men require both wings and ballast. A man cannot

et volatum. Atque hoc adhuc factum non est; quum vero factum fuerit, melius de scientiis sperare licebit.

CV.

In constituendo autem axiomate, forma *inductionis* alia quam adhuc in usu fuit excogitanda est; eaque non ad principia tantum (quae vocant) probanda et invenienda, sed etiam ad axiomata minora et media, denique omnia. Inductio enim quae procedit per enumerationem simplicem[94] res puerilis est, et precario[95] concludit, et periculo exponitur ab instantia contradictoria[96], et plerumque secundum pauciora quam par est, et ex his tantummodo quae praesto sunt[97], pronunciat. At *inductio*, quae ad inventionem et demonstrationem scientiarum et artium erit utilis[98], naturam separare

have too fertile an imagination, but his imaginative powers should be combined with a keen perception of the requirements of evidence and with corresponding critical acumen. Bacon has really hit the mark in Aph. 57.

[94] On the Inductio per Enumerationem Simplicem, and the distinction between it and Scientific Induction ('quae ad inventionem et demonstrationem scientiarum et artium est utilis'), see my Inductive Logic, 3rd ed., pp. 7–9, 122–124, 214–221, 274–293. In reading these passages, the student must distinguish between the legitimate and illegitimate, as well as between the necessary and unnecessary, employment of the Inductio per Enumerationem Simplicem.

[95] That is, on no certain grounds.

[96] A single contradictory instance is generally sufficient to overthrow an induction based on simple enumeration, but, where an induction is based on elimination and seems to establish a causal connection, the strong presumption is that any exception is apparent only and is really due to some counteracting cause. Cp. Cogitata et Visa (E. and S., vol. iii. p. 618): 'Visum est ei, talem inductionis formam inveniendam, quae ex aliquibus generaliter concludat; ita ut instantiam contradictoriam inveniri non posse demonstretur.'

[97] Thus, a man living in one part of the globe might infer from the men whom he had seen that all men are white, a man living in another part that all men are black, and so on.

[98] This is Scientific Induction, as distinguished from Inductio per Enumerationem Simplicem. But, though Bacon had formed the idea of a Scientific Induction, or a process of elimination by means of which causes might be detected, his own account of the process and of the rules by which it should be conducted is vague and not sufficiently adapted to practice. Subsequent writers, especially Sir John Herschel, Dr. Whewell, and Mr. Mill, have rendered these rules at once more precise and better adapted to practice. See notes on Bk. ii. Aphs. 11–18, and Introduction, §§ 9, 15.

debet, per rejectiones et exclusiones debitas; ac deinde, post negativas tot quot sufficiunt, super affirmativas concludere [99]; quod adhuc factum non est, nec tentatum certe, nisi tantummodo a Platone [1], qui ad excutiendas [2] definitiones et ideas [3]

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[99] There can be no question that Bacon is here alluding to the Method of Exclusions, of which he gives an instance in Bk. ii. Aph. 18. See note 68 on the ambiguous passage in Bk. i. Aph. 69. The second of the alternative explanations, which were there proposed, is, of course, the one which is applicable here.

The defects of Bacon's Method of Exclusion (for a further account of which see § 9 of the Introduction to this edition and Mr. Ellis's Preface to Bacon's Philosophical Works, E. and S., vol. i. pp. 22–39) are tolerably obvious. There is, first, the difficulty, amounting, in most cases, almost to impossibility, of ascertaining that all the possible explanations or causes of the given phenomenon have been passed in review. Then, again, we not only require rules to exclude false theories, but also tests to satisfy ourselves of the truth of the theory which we ultimately adopt. These, however, Bacon might have maintained, are, at least, suggested in ii. 15, and, to a certain extent, supplied in some of the Praerogativae Instantiarum.

[1] But in the Temporis Partus Masculus (E. and S., vol. iii. p. 530) he abuses Plato, amongst other things, for his Induction, and apostrophises him thus: '. . . . . . animosque vagis inductionibus tentares et exsolveres.' By the Platonic Induction in that and the present passage, he probably means two different things. In the Temporis Partus Masculus, he is alluding probably to what is usually understood by the Platonic or Socratic Induction, the ἐπακτικοὶ λόγοι, or παραβολή, which (except in the fact that it generally argues from a number of instances, instead of generally arguing from a single instance) answers to the Example of Aristotle or the Analogy of modern Logic. For an account of this mode of reasoning, see the Introduction to Mansel's Edition of Aldrich, 4th ed., p. xx. But the 'forma inductionis' to which Bacon alludes in this Aphorism is undoubtedly the Method of Exclusion, as practised by Plato. When he wishes to settle the meaning of a term, his usual method (of which we may see an excellent instance, with regard to δικαιοσύνη, in the 1st book of the Republic) is to bring forward a number of interlocutors, who, one after the other, make the attempt; each, in his turn, is refuted, generally by an application of the Socratic παραβολή, or induction in the sense just described; then, the question is either left unsettled (as in the Euthyphron), or Socrates himself proposes a definition, which is accepted as final. But, if the affirmative Socrates stands his ground, it is only because, as Mr. Grote says, there is no negative Socrates to cross-question him. In fact, this allusion to the Platonic Method of Rejection brings into prominence the objections to the method generally. How can we be certain that all the possible definitions have been started, and what guarantee have we of the correctness of the one which is ultimately adopted?

[2] This word implies both discussion and determination.

[3] The word, I think, here stands for the ἰδέαι of Plato. Its use as

hac certe forma inductionis aliquatenus utitur. Verum ad hujus inductionis, sive demonstrationis [4], instructionem bonam et legitimam quamplurima adhibenda sunt, quae adhuc nullius mortalium cogitationem subiere; adeo ut in ea major sit consumenda opera, quam adhuc consumpta est in syllogismo [5]. Atque hujus inductionis auxilio, non solum ad axiomata invenienda, verum etiam ad notiones terminandas [6], utendum est. Atque in hac certe *inductione* spes maxima sita est.

CVI.

At in axiomatibus constituendis per hanc inductionem, examinatio et probatio etiam facienda est, utrum quod constituitur axioma aptatum sit tantum et ad mensuram factum eorum particularium ex quibus extrahitur; an vero sit amplius et latius [7]. Quod si sit amplius aut latius, videndum an eam suam amplitudinem et latitudinem per novorum particularium designationem, quasi fide-jussione quadam, firmet [8]; ne vel in jam notis tantum haereamus, vel laxiore

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= notiones, was, before the time of David Buchanan and Descartes, exceedingly rare. See Hamilton on Reid, Appendix, Note G, where the student will find a most interesting account of the history of the word. In Aph. 23 and elsewhere, Bacon uses it in its scholastic sense, as appropriated to the forms of the Divine Mind, 'divinae mentis ideae.' See note 29 on Aph. 23.

[4] Bacon probably uses this term, usually appropriated to mathematical proof, of set purpose. He conceived, and conceived, I think, rightly, that Induction, if properly conducted, is capable of affording evidence positively certain.

[5] Any one acquainted with the subsequent history of scientific discovery and scientific method will admire the wonderful foresight displayed by Bacon in this sentence.

[6] Thus, for instance, if we arrive at a true axiom on the nature of heat, we shall be better able to define the term or notion. Cp. Aph. 14 and note 17.

[7] Cp. Aph. 70 and note 72. We here again come across the distinction since expressed by the terms 'Empirical Law' and 'Law of Nature.'

[8] Mr. Adamson (Encyclopaedia Britannica, vol. iii. p. 217) is quite right in saying that this Aphorism appears to introduce the idea of hypothesis. He might also have added that it introduces the idea of verification, including prediction. As to the nature of the 'fidejussio,' I may remark that the circumstance of a scientific generalisation enabling us to predict the future affords a strong confirmation of its truth, though

fortasse complexu umbras et formas abstractas, non solida et determinata in materia, prensemus. Haec vero cum in usum venerint, solida tum demum spes merito affulserit.

CVII.

Atque hic etiam resumendum est, quod superius dictum est[9] de Naturali Philosophia producta et scientiis particularibus ad eam reductis, ut non fiat scissio et truncatio scientiarum; nam etiam absque hoc minus de progressu sperandum est.

CVIII.

Atque de desperatione tollenda et spe facienda, ex praeteriti temporis erroribus valere jussis aut rectificatis, jam dictum est. Videndum autem et si quae alia sint quae spem faciant. Illud vero occurrit; si hominibus non quaerentibus, et aliud agentibus, multa utilia, tanquam casu quodam aut per occasionem, inventa sint; nemini dubium esse posse, quin iisdem quaerentibus et hoc agentibus, idque via et ordine,

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it does not positively prove it. See my Inductive Logic, 3rd ed., pp. 113–119.

Mr. Spedding very appositely quotes the following passage from Valerius Terminus (E. and S., vol. iii. p. 242): 'That the discovery of new works and active directions not known before, is the only trial to be accepted of; and yet not that neither, in case where one particular giveth light to another; but where particulars induce an axiom or observation, which axiom found out discovereth and designeth new particulars. That the nature of this trial is not only upon the point, whether the knowledge be profitable or no, but even upon the point whether the knowledge be true or no; not because you may always conclude that the Axiom which discovereth new instances is true, but contrariwise you may safely conclude that if it discover not any new instance it is in vain and untrue.'

[9] See Aphs. 79, 80, with the notes upon them. Here, as in those Aphorisms, there seems to be some confusion between Natural Philosophy and the Philosophia Prima. The metaphors 'scissio et truncatio' certainly apply to the Philosophia Prima, as described in De Augmentis, lib. iii. cap. 1, rather than to Natural Philosophy, as described in the subsequent chapters of the same Book.

Of the justice, however, of Bacon's remark, and of its supreme importance, there can be no doubt. The results of the labours of specialists require to be gathered together into one science, and the various sciences themselves to be compared and brought into harmony, if human knowledge is to progress as a whole and we are to command a real insight into the ways of nature.

non impetu et desultorie, longe plura detegi necesse sit. Licet enim semel aut iterum accidere possit, ut quispiam in id forte fortuna incidat, quod magno conatu et de industria scrutantem antea fugit; tamen in summa rerum proculdubio contrarium invenitur. Itaque longe plura et meliora, atque per minora intervalla, a ratione et industria et directione et intentione hominum speranda sunt, quam a casu et instinctu animalium et hujusmodi, quae hactenus principium inventis dederunt.

CIX.

Etiam illud ad spem trahi possit, quod nonnulla ex his quae jam inventa sunt ejus sint generis ut antequam invenirentur haud facile cuiquam in mentem venisset de iis aliquid suspicari; sed plane quis illa ut impossibilia contempsisset. Solent enim homines de rebus novis ad exemplum veterum, et secundum phantasiam ex iis praeceptam et inquinatam, hariolari; quod genus opinandi fallacissimum est, quandoquidem multa ex his quae ex fontibus rerum petuntur per rivulos consuetos non fluant.

Veluti si quis, ante tormentorum igneorum [10] inventionem, rem per effectus descripsisset, atque in hunc modum dixisset: inventum quoddam detectum esse, per quod muri et munitiones quaeque maximae ex longo intervallo concuti et dejici possint; homines sane de viribus tormentorum et machinarum per pondera et rotas et hujusmodi arietationes et impulsus multiplicandis, multa et varia secum cogitaturi fuissent; de vento autem igneo [11], tam subito et violenter se expandente

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[10] Cannon. 'Large pieces, which were conveyed on cars or carriages, were called karrenbüchse, but soon after also canna, cannon.' 'These karrenbüchsen with a wheel were invented in Germany in the beginning of the sixteenth century.' 'Martin Bellay, speaking of the league formed between the emperor Charles V and pope Leo X against France, and the siege of Parma undertaken in the year 1521, says, "De ceste heure là furent inventées les harcquebouzes qu'on tiroit sur une fourchette."'—Beckmann's History of Inventions.

[11] Beckmann 'is inclined to accede to the opinion of those who believe that gunpowder was invented in India, and brought by the Saracens from Africa to the Europeans, who however improved the preparation of it, and found out different ways of employing it in war.' 'The preparation of gunpowder,' he thinks, 'became known in Europe in the thirteenth cen-

et exsufflante, vix unquam aliquid alicujus imaginationi aut phantasiae occursurum fuisset; utpote cujus exemplum in proximo non vidisset, nisi forte in terrae motu aut fulmine, quae, ut magnalia naturae et non imitabilia ab homine, homines statim rejecturi fuissent.

Eodem modo si, ante fili bombycini[12] inventionem, quispiam hujusmodi sermonem injecisset: esse quoddam fili genus inventum ad vestium et supellectilis usum, quod filum linteum aut laneum tenuitate, et nihilominus tenacitate, ac etiam splendore et mollitie, longe superaret; homines statim aut de serico aliquo vegetabili, aut de animalis alicujus pilis delicatioribus, aut de avium plumis et lanugine, aliquid opinaturi fuissent; verum de vermis pusilli textura, eaque tam copiosa et se renovante et anniversaria, nil fuissent certe commenturi. Quod si quis etiam de vermi verbum aliquod injecisset, ludibrio certe futurus fuisset, ut qui novas aranearum operas somniaret.

Similiter, si ante inventionem acus nauticae[13] quispiam hujusmodi sermonem intulisset: inventum esse quoddam instrumentum, per quod cardines et puncta coeli exacte capi et dignosci possint; homines statim de magis exquisita fabricatione instrumentorum astronomicorum ad multa et varia, per agitationem phantasiae, discursuri fuissent; quod vero aliquid inveniri possit, cujus motus cum coelestibus tam bene conveniret, atque ipsum tamen ex coelestibus non esset, sed

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tury, about the same time that the use of the Greek fire, of which there were many kinds, began to be lost.'

[12] Silk (sericum) was so called as coming from the country of the Seres or Chinese, where its cultivation appears to go back to the highest antiquity. It was known both to the Greeks and Romans.

[13] The Mariner's Compass. 'The directive power of the magnet seems to have been unknown in Europe till late in the twelfth century. It appears, however, on very good authority, that it was known in China, and throughout the East generally, at a very remote period. * * * * * At first, the Chinese would appear to have used it exclusively for guidance in travelling by land. The earliest date at which we hear of their using it at sea is somewhere about 300 A.D." Chambers' Encyclopaedia. It is sometimes stated that Marco Polo brought the Compass with him from China to Italy in 1260, but there is evidence of its use in Europe in the previous century.

tantum substantia lapidea aut metallica[14], omnino incredibile visum fuisset. Atque haec tamen et similia per tot mundi aetates homines latuerunt, nec per philosophiam aut artes rationales inventa sunt, sed casu et per occasionem; suntque illius (ut diximus) generis, ut ab iis quae antea cognita fuerunt plane heterogenea et remotissima sint, ut praenotio aliqua nihil prorsus ad illa conducere potuisset.

Itaque sperandum omnino est, esse adhuc in naturae sinu multa excellentis usus recondita, quae nullam cum jam inventis cognationem habent aut parallelismum, sed omnino sita sunt extra vias phantasiae; quae tamen adhuc inventa non sunt; quae proculdubio per multos saeculorum circuitus et ambages et ipsa quandoque prodibunt, sicut illa superiora prodierunt; sed per viam, quam nunc tractamus, propere et subito et simul repraesentari[15] et anticipari possunt.

CX.

Attamen conspiciuntur et alia inventa ejus generis, quae fidem faciant, posse genus humanum nobilia inventa, etiam ante pedes posita, praeterire et transilire. Utcunque enim pulveris tormentarii vel fili bombycini vel acus nauticae vel sacchari vel papyri vel similium inventa quibusdam rerum et naturae proprietatibus niti videantur, at certe imprimendi artificium nil habet quod non sit apertum et fere obvium. Et nihilominus homines, non advertentes literarum modulos difficilius scilicet collocari quam literae per motum manus scribantur, sed hoc interesse, quod literarum moduli semel collocati infinitis impressionibus, literae autem per manum exaratae unicae tantum scriptioni, sufficiant; aut fortasse iterum non advertentes atramentum ita inspissari posse, ut tingat, non fluat; praesertim[16] literis resupinatis et impressione facta desuper; hoc pulcherrimo invento (quod ad

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[14] In Bk. ii. Aph. 36, an 'instantia crucis' is proposed for the purpose of determining the cause of the Polarity of the Needle.

[15] 'Be presented at once,' without any delay. This word, besides its ordinary meaning, has two others: (a) to pay on the spot; to pay in ready money: (β) to perform an act immediately, without delay.

[16] This is given as a reason why ink was needed, which should stain without running.

doctrinarum propagationem tantum facit) per tot saecula caruerunt [17].

Solet autem mens humana, in hoc inventionis curriculo, tam laeva saepenumero et male composita esse, ut primo diffidat, et paulo post se contemnat; atque primo incredibile ei videatur aliquid tale inveniri posse, postquam autem inventum sit, incredibile rursus videatur id homines tamdiu fugere potuisse. Atque hoc ipsum ad spem rite trahitur; superesse nimirum adhuc magnum inventorum cumulum, qui non solum ex operationibus incognitis eruendis, sed et ex jam cognitis transferendis et componendis et applicandis, per eam quam diximus Experientiam Literatam [18], deduci possit.

CXI.

Neque illud omittendum ad faciendam spem: reputent (si placet) homines infinitas ingenii, temporis, facultatum expensas, quas homines in rebus et studiis longe minoris usus et pretii collocant; quorum pars quota si ad sana et solida verteretur, nulla non difficultas superari possit. Quod idcirco adjungere visum est, quia plane fatemur Historiae Naturalis et Experimentalis collectionem, qualem animo metimur et qualis esse debet, opus esse magnum, et quasi regium, et multae operae atque impensae.

CXII.

Interim particularium multitudinem nemo reformidet, quin potius hoc ipsum ad spem revocet. Sunt enim artium et naturae particularia Phaenomena manipuli instar ad ingenii

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[17] The honour of the invention of printing from moveable types has been much disputed. It is generally ascribed either to John Lorenzo Koster of Haarlem or to John Guttemberg of Mainz. All that we can say with certainty is that it is due to the middle of the fifteenth century. In order to carry the art to any perfection, it was necessary to invent not only moveable types, but also an ink more viscous and tenacious than the ordinary ink. It may be added that the Chinese had from time immemorial been acquainted with the art of printing from blocks of wood. What constituted the novelty of European printing was the use of moveable types.

[18] This expression is here used in the same sense as in Aph. 103 and the De Augmentis.

commenta, postquam ab evidentia rerum disjuncta et abstracta fuerint. Atque hujus viae exitus in aperto est, et fere in propinquo; alterius exitus nullus, sed implicatio infinita. Homines enim adhuc parvam in Experientia moram fecerunt, et eam leviter perstrinxerunt, sed in meditationibus et commentationibus ingenii infinitum tempus contriverunt. Apud nos vero si esset praesto quispiam qui de facto naturae [19] ad interrogata responderet, paucorum annorum esset inventio causarum et scientiarum omnium.

CXIII.

Etiam nonnihil hominibus spei fieri posse putamus ab exemplo nostro proprio; neque jactantiae causa hoc dicimus sed quod utile dictu sit. Si qui diffidant, me videant, hominem inter homines aetatis meae civilibus negotiis occupatissimum [20], nec firma admodum valetudine (quod magnum habet temporis dispendium), atque in hac re plane protopirum [21], et vestigia nullius sequutum, neque haec ipsa cum ullo mortalium communicantem, et tamen veram viam constanter ingressum et ingenium rebus submittentem, haec ipsa aliquatenus (ut existimamus) provexisse: et deinceps videant, quid ab hominibus otio abundantibus, atque a laboribus consociatis, atque a temporum successione, post haec indicia nostra expectandum sit; praesertim in via quae non singulis solummodo pervia est (ut fit in via illa rationali), sed ubi hominum labores et

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[19] The great difficulty, Bacon seems to have thought, was to ascertain the facts of nature, rather than to draw the right inferences from them. Here, again, we see the importance which he attached to a properly and adequately constituted Natural History.

[20] In the Cogitata et Visa (E. and S., vol. iii. p. 619), he speaks of himself as 'rebus civilibus plus quam vellet immistus.' The union of scientific and civil employments, to which Bacon here alludes, reminds us of Cowley's celebrated lines:

'Bacon, at last, a mighty man, arose,
Whom a wise King and Nature chose
Lord-Chancellor of both their laws.'

[21] Πρωτόπειρος, the first man to make the trial. The account, given in the Introduction, § 13, of authors contemporary with or earlier than Bacon, who had anticipated portions of his teaching, will shew that there is some exaggeration in this statement. Perhaps, however, he is referring only to the Inductive Method delineated in Bk. ii.

operae (praesertim quantum ad experientiae collectam) optime distribui et deinde componi possint. Tum enim homines vires suas nosse incipient, cum non eadem infiniti, sed alia alii praestabunt [22].

CXIV.

Postremo, etiamsi multo infirmior et obscurior aura spei ab ista Nova Continente spiraverit [23], tamen omnino experiendum esse (nisi velimus animi esse plane abjecti) statuimus. Non enim res pari periculo non tentatur, et non succedit; cum in illo ingentis boni, in hoc exiguae humanae operae, jactura vertatur. Verum ex dictis, atque etiam ex non dictis, visum est nobis spei abunde subesse, non tantum homini strenuo ad experiendum, sed etiam prudenti et sobrio ad credendum.

CXV.

Atque de desperatione tollenda, quae inter causas potentissimas ad progressum scientiarum remorandum et inhibendum fuit, jam dictum est. Atque simul sermo de signis et causis errorum, et inertiae et ignorantiae quae invaluit, absolutus est; praesertim cum subtiliores causae, et quae in judicium populare aut observationem non incurrunt, ad ea quae de Idolis animi humani dicta sunt referri debeant.

Atque hic simul pars destruens Instaurationis nostrae claudi debet, quae perficitur tribus redargutionibus: redargutione nimirum *Humanae Rationis Nativae* et sibi permissae; redargutione *Demonstrationum;* et redargutione *Theoriarum*, sive philosophiarum et doctrinarum quae receptae sunt [24].

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[22] This sentence would form a good motto for Adam Smith's chapters on the Division of Labour.

[23] 'Bacon refers to what Peter Martyr Anghiera has related, that Columbus observing the west winds which blow at certain times of the year on the coast of Portugal came to the conclusion that there must be land to generate them.' Mr. Ellis' note.

[24] See notes on Aphs. 38, 39, with the passages in Ellis and Spedding's Edition there referred to. In a note on the Distributio Operis, Mr. Spedding remarks that there the three Redargutiones are enumerated in the reverse order to that in which they are enumerated in this Aphorism, and in which they are treated in the Novum Organum. 'This shows,' he says, 'that the Distributio Operis was written before Bacon had decided upon the arrangement of the Novum Organum.' The enumeration in the Partis

Redargutio vero earum talis fuit qualis esse potuit; videlicet per signa, et evidentiam causarum; cum confutatio alia nulla a nobis (qui et de principiis et de demonstrationibus ab aliis dissentimus) adhiberi potuerit.

Quocirca tempus est, ut ad ipsam artem et normam Interpretandi Naturam veniamus; et tamen nonnihil restat quod praevertendum est. Quum enim in hoc primo Aphorismorum libro illud nobis propositum sit, ut tam ad intelligendum quam ad recipiendum ea quae sequuntur mentes hominum praeparentur; expurgata jam et abrasa et aequata mentis area, sequitur ut mens sistatur in positione bona, et tanquam aspectu benevolo, ad ea quae proponemus[25]. Valet enim in re nova ad praejudicium, non solum praeoccupatio fortis opinionis veteris, sed et praeceptio sive praefiguratio falsa rei quae affertur. Itaque conabimur efficere ut habeantur bonae et verae de iis quae adducimus opiniones, licet ad tempus tantummodo, et tanquam usurariae, donec res ipsa pernoscatur.

CXVI.

Primo itaque[26] postulandum videtur, ne existiment homines nos, more antiquorum Graecorum, aut quorundam novorum hominum, Telesii, Patricii, Severini[27], sectam aliquam in philo-

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Secundae Delineatio (E. and S., vol. iii. p. 548) corresponds with that in the Distributio Operis.

The 'Redargutio Humanae Rationis Nativae et sibi permissae' includes, of course, the doctrine of the Idola Tribus, Idola Specus, and Idola Fori.

[25] The mirror being now polished, it must be placed in such a position as to catch the sun's rays.

[26] In this and the two next Aphorisms, we have three cautions or warnings. The first is, that the author does not wish to found a sect, or even to propound a complete theory; the second, that particular effects ought not to be expected at first; the third, that mistakes will be sure to occur in the history and tables of discovery.

[27] Cp. De Augmentis, lib. iii. cap. 4 (E. and S., vol. i. p. 564): 'Neque vero ex hoc *Placitorum Philosophiae Kalendario* nuperas theorias et dogmata excludo; sicut illam Theophrasti Paracelsi, eloquenter in corpus quoddam et harmoniam philosophiae redactam a Severino Dano; aut Telesii Consentini, qui Parmenidis philosophiam instaurans arma Peripateticorum in illos ipsos vertit; aut Patricii Veneti, qui Platonicorum fumos sublimavit; aut Gilberti popularis nostri, qui Philolaï dogmata reposuit; aut alterius cujuscunque, si modo dignus sit.' To Telesius, whom he calls 'the best of the Novellists,' Bacon refers, perhaps, more than to any other modern writer.

sophia condere velle. Neque enim hoc agimus; neque etiam multum interesse putamus ad hominum fortunas quales quis opiniones abstractas de natura et rerum principiis habeat; neque dubium est, quin multa hujusmodi et vetera revocari et nova introduci possint; quemadmodum et complura themata coeli supponi possunt, quae cum phaenomenis sat bene conveniunt, inter se tamen dissentiunt.

At nos de hujusmodi rebus opinabilibus, et simul inutilibus, non laboramus. At contra nobis constitutum est experiri, an revera potentiae et amplitudinis humanae firmiora fundamenta jacere ac fines in latius proferre possimus[28]. Atque licet sparsim, et in aliquibus subjectis specialibus, longe veriora habeamus et certiora (ut arbitramur) atque etiam magis fructuosa quam quibus homines adhuc utuntur (quae in quintam[29] Instaurationis nostrae partem congessimus), tamen theoriam nullam universalem aut integram proponimus. Neque enim huic rei tempus adhuc adesse videtur. Quin nec spem habemus vitae producendae ad sextam[30] Instaurationis partem (quae philosophiae per legitimam Naturae Interpretationem inventae destinata est) absolvendam; sed satis habemus si in mediis sobrie et utiliter nos geramus, atque interim semina veritatis sincerioris in posteros spargamus, atque initiis rerum magnarum non desimus.

The Severinus, alluded to in this Aphorism, is probably the same as 'Severinus the Dane' (b. 1542, d. 1602), who must be distinguished from his more celebrated namesake, Marcus Aurelius Severinus, the Calabrian. Both these authors, as well as Telesius and Patricius, are referred to in the Introduction to this Edition.

It is curious that in the Temporis Partus Masculus, where Bacon's judgments are usually extremely severe, Severinus the Dane should be specially selected for commendation: 'Invideo tibi (Paracelse) e sectatoribus tuis unum Petrum Severinum, virum non dignum qui istis ineptiis immoriatur.' (E. and S., vol. iii. p. 533.)

[28] Cp. the title of the Novum Organum, 'Aphorismi de Interpretatione Naturae et Regno Hominis.'

[29] This was to be entitled 'Prodromi sive Anticipationes Philosophiae Secundae.' The Preface to it is published at the end of Ellis and Spedding's second volume.

[30] This was to be entitled 'Philosophia Secunda, sive Scientia Activa.' There is a fine description of it in the Distributio Operis. See p. 176.

CXVII.

Atque quemadmodum sectae conditores non sumus, ita nec operum particularium largitores aut promissores. Attamen possit aliquis hoc modo occurrere; quod nos, qui tam saepe operum mentionem faciamus et omnia eo trahamus, etiam operum aliquorum pignora exhibeamus. Verum via nostra et ratio (ut saepe perspicue diximus et adhuc dicere juvat) ea est; ut non opera ex operibus sive experimenta ex experimentis (ut empirici), sed ex operibus et experimentis causas et axiomata, atque ex causis et axiomatibus rursus nova opera et experimenta (ut legitimi Naturae Interpretes), extrahamus.

Atque licet in tabulis nostris inveniendi (ex quibus quarta pars [31] Instaurationis consistit), atque etiam exemplis particularium (quae in secunda parte adduximus), atque insuper in observationibus nostris super historiam (quae in tertia parte [32] operis descripta est), quivis vel mediocris perspicaciae et solertiae complurium operum nobilium indicationes et designationes ubique notabit; ingenue tamen fatemur, historiam naturalem quam adhuc habemus, aut ex libris aut ex inquisitione propria, non tam copiosam esse et verificatam, ut legitimae Interpretationi satisfacere aut ministrare possit [33].

Itaque si quis ad mechanica sit magis aptus et paratus, atque sagax ad venanda opera ex conversatione sola cum experimentis, ei permittimus et relinquimus illam industriam, ut ex historia nostra et tabulis multa tanquam in via decerpat et applicet ad opera, ac veluti foenus recipiat ad tempus, donec sors haberi possit. Nos vero, cum ad majora contendamus, moram omnem praeproperam et praematuram in istiusmodi rebus tanquam Atalantae pilas (ut saepius solemus dicere) damnamus. Neque enim aurea poma pueriliter affectamus,

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[31] The 'Scala Intellectus.' Cp. note 62 on Aph. 92.

[32] The 'Phaenomena Universi, sive Historia Naturalis et Experimentalis ad condendam Philosophiam.' Cp. note 76 on Aph. 98.

[33] This 'candid confession' of Bacon should be taken in excuse of the many shortcomings of the part of his work here referred to, and in deprecation of the hostile criticisms of Liebig and others. Cp. the next Aphorism, and Introduction, p. 141.

sed omnia in victoria cursus artis super naturam [34] ponimus; neque muscum aut segetem herbidam demetere festinamus, sed messem tempestivam expectamus.

CXVIII.

Occurret etiam alicui proculdubio, postquam ipsam historiam nostram et inventionis tabulas perlegerit, aliquid in ipsis experimentis minus certum, vel omnino falsum; atque propterea secum fortasse reputabit, fundamentis et principiis falsis et dubiis inventa nostra niti. Verum hoc nihil est; necesse enim est talia sub initiis evenire. Simile enim est ac si in scriptione aut impressione una forte litera aut altera perperam posita aut collocata sit; id enim legentem non multum impedire solet, quandoquidem errata ab ipso sensu facile corriguntur. Ita etiam cogitent homines, multa in historia naturali experimenta falso credi et recipi posse, quae paulo post a causis et axiomatibus inventis facile expunguntur et rejiciuntur. Sed tamen verum est, si in historia naturali et experimentis magna et crebra et continua fuerint errata, illa nulla ingenii aut artis foelicitate corrigi aut emendari posse. Itaque si in historia nostra naturali, quae tanta diligentia et severitate et fere religione probata et collecta est, aliquid in particularibus quandoque subsit falsitatis aut erroris, quid tandem de naturali historia vulgari, quae prae nostra tam negligens est et facilis, dicendum erit? aut de philosophia et scientiis super hujusmodi arenas (vel syrtes potius) aedificatis? Itaque hoc quod diximus neminem moveat.

CXIX.

Occurrent etiam in historia nostra et experimentis plurimae res, primo leves et vulgatae, deinde viles et illiberales, postremo nimis subtiles ac mere speculativae, et quasi nullius usus: quod genus rerum hominum studia avertere et alienare possit [35].

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[34] That is, the 'regnum hominis.' But then this victory over nature can only be acquired by patient observation of her ways. 'Natura enim non nisi parendo vincitur.'

[35] In this and the two next Aphorisms, we have three apologies, namely,

Atque de istis rebus, quae videntur vulgatae, illud homines cogitent; solere sane eos adhuc nihil aliud agere, quam ut eorum quae rara sunt causas ad ea quae frequenter fiunt referant et accommodent, at ipsorum quae frequenter eveniunt nullas causas inquirant, sed ea ipsa recipiant tanquam concessa et admissa.

Itaque non ponderis, non rotationis coelestium [36], non caloris, non frigoris, non luminis, non duri, non mollis, non tenuis, non densi, non liquidi, non consistentis, non animati, non inanimati, non similaris, non dissimilaris, nec demum organici, causas quaerunt; sed illis, tanquam pro evidentibus et manifestis, receptis, de ceteris rebus, quae non tam frequenter et familiariter occurrunt, disputant et judicant.

Nos vero, qui satis scimus nullum de rebus raris aut notabilibus judicium fieri posse, multo minus res novas in lucem protrahi, absque vulgarium rerum causis et causarum causis rite examinatis et repertis, necessario ad res vulgarissimas in historiam nostram recipiendas compellimur. Quinetiam nil magis philosophiae offecisse deprehendimus quam quod res, quae familiares sunt et frequenter occurrunt, contemplationem hominum non morentur et detineant, sed recipiantur obiter, neque earum causae quaeri soleant: ut non saepius requiratur informatio de rebus ignotis, quam attentio in notis.

CXX.

Quod vero ad rerum vilitatem attinet, vel etiam turpitudinem, quibus (ut ait Plinius [37]) honos praefandus est; eae res, non minus quam lautissimae et pretiosissimae, in historiam naturalem recipiendae sunt. Neque propterea polluitur natu-

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for the occurrence in the Natural History of common things, of base things, and of subtle things.

[36] To have asked this question should surely be put down to Bacon's credit. The *cause* of the celestial motions was first discovered by Newton.

[37] 'Rerum natura, hoc est, vita narratur, et haec sordidissima sui parte, ut plurimarum rerum aut rusticis vocabulis aut externis, immo barbaris, etiam cum honoris praefatione ponendis.' Nat. Hist., lib. i. ad init. The expression 'honorem praefari' means 'to apologise,' 'to ask permission' in using an indelicate phrase. Cp. Cicero, Epistolae ad Diversos, lib. ix. ep. 22: 'Si dicimus, ille patrem strangulavit, honorem non praefamur. Sin de Aurelia aliquid, aut Lollia: honos praefandus est.'

ralis historia: sol enim aeque palatia et cloacas ingreditur, neque tamen polluitur. Nos autem non Capitolium aliquod aut Pyramidem hominum superbiae dedicamus aut condimus, sed templum sanctum ad exemplar mundi in intellectu humano fundamus. Itaque exemplar sequimur. Nam quicquid essentia dignum est, id etiam scientia dignum, quae est essentiae imago[38]. At vilia aeque subsistunt ac lauta. Quinetiam, ut e quibusdam putridis materiis, veluti musco et zibetho[39], aliquando optimi odores generantur; ita et ab instantiis vilibus et sordidis quandoque eximia lux et informatio emanat. Verum de hoc nimis multa; cum hoc genus fastidii sit plane puerile et effoeminatum.

CXXI.

At de illo omnino magis accurate dispiciendum; quod plurima in historia nostra captui vulgari, aut etiam cuivis intellectui (rebus praesentibus assuefacto), videbuntur curiosae cujusdam et inutilis subtilitatis. Itaque de hoc ante omnia et dictum et dicendum est: hoc scilicet; nos jam sub initiis et ad tempus, tantum *lucifera* experimenta, non *fructifera* quaerere; ad exemplum creationis divinae, quod saepius diximus, quae primo die lucem tantum produxit, eique soli unum integrum diem attribuit, neque illo die quicquam materiati operis immiscuit.

Itaque si quis istiusmodi res nullius esse usus putet, idem cogitat ac si nullum etiam lucis esse usum censeat, quia res scilicet solida aut materiata non sit. Atque revera dicendum est, simplicium naturarum[40] cognitionem bene examinatam et

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[38] With the various questions as to the correspondence or relation of knowledge to being, which were to occupy so much of the attention of subsequent philosophers, Bacon did not concern himself. That knowledge would correspond with being, if we were once to dispel the phantoms which beset us and lay our minds alongside of facts, he took for granted.

[39] Musk and civet.

[40] This passage is important as throwing light both on Bacon's theory of Forms and on his theory of Induction. He seems to have thought it possible to discover the ultimate elements (simplices naturae), out of which all the manifold and intricate effects in Nature are compounded, just as all words and sentences, however numerous and complex they may be, are compounded out of the letters of the alphabet. When these 'simple

definitam instar lucis esse; quae ad universa operum penetralia aditum praebet, atque tota agmina operum et turmas, et axiomatum nobilissimorum fontes, potestate quadam complectitur et post se trahit; in se tamen non ita magni usus est. Quin et literarum elementa per se et separatim nihil significant nec alicujus usus sunt, sed tamen ad omnis sermonis compositionem et apparatum instar materiae primae sunt. Etiam semina rerum potestate valida, usu (nisi in processu suo) nihili sunt. Atque lucis ipsius radii dispersi, nisi coeant, beneficium suum non impertiuntur.

Quod si quis subtilitatibus speculativis offendatur, quid de scholasticis viris dicendum erit, qui subtilitatibus immensum indulserunt? quae tamen subtilitates in verbis, aut saltem vulgaribus notionibus (quod tantundem valet), non in rebus aut natura consumptae fuerunt, atque utilitatis expertes erant, non tantum in origine, sed etiam in consequentiis; tales autem non fuerunt, ut haberent in praesens utilitatem nullam, sed per consequens infinitam; quales sunt eae de quibus loquimur. Hoc vero sciant homines pro certo, omnem subtilitatem disputationum et discursuum mentis, si adhibeatur tantum post axiomata inventa, seram esse et praeposteram; et subtilitatis tempus verum ac proprium, aut saltem praecipuum, versari in pensitanda experientia et inde constituendis axiomatibus: nam illa altera subtilitas naturam prensat et captat, sed nunquam apprehendit aut capit[41]. Et verissimum certe est quod de occasione sive fortuna dici solet, si transferatur ad naturam: videlicet, *eam a fronte comatam, ab occipitio calvam esse*[42].

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natures' were discovered, it would be easy, he conceived, by rejecting first one and then another, to ascertain, through the method of Exclusion, the Form or Cause of any given phenomenon. See Introduction, § 9, and Mr. Ellis' General Preface to Bacon's Philosophical Works, pp. 25–39.

[41] For it is 'subtilitati naturae longe impar.' 'Assensum itaque constringit, non res.' Cp. Aphs. 10–14.

[42] See Phaedrus' Fables, lib. v. fab. 8:

'Occasio Depicta.
Cursu volucri pendens in novacula,
Calvus, comosa fronte, nudo corpore,
Quem si occuparis, teneas: elapsum semel
Non ipse possit Jupiter reprehendere;
Occasionem rerum significat brevem.

Denique de contemptu in naturali historia rerum aut vulgarium, aut vilium, aut nimis subtilium et in originibus suis inutilium, illa vox mulierculae ad tumidum principem, qui petitionem ejus ut rem indignam et majestate sua inferiorem abjecisset, pro oraculo sit; *Desine ergo rex esse*[43]*:* quia certissimum est, imperium in naturam, si quis hujusmodi rebus ut nimis exilibus et minutis vacare nolit, nec obtineri nec geri posse.

CXXII.

Occurrit[44] etiam et illud; mirabile quiddam esse et durum, quod nos omnes scientias atque omnes authores simul ac veluti uno ictu et impetu summoveamus: idque non assumpto aliquo ex antiquis in auxilium et praesidium nostrum, sed quasi viribus propriis.

Nos autem scimus, si minus sincera fide agere voluissemus, non difficile fuisse nobis, ista quae afferuntur vel ad antiqua saecula ante Graecorum tempora (cum scientiae de natura magis fortasse sed tamen majore cum silentio floruerint, neque in Graecorum tubas et fistulas adhuc incidissent), vel etiam (per partes certe) ad aliquos ex Graecis ipsis referre, atque astipulationem et honorem inde petere: more novorum hominum, qui nobilitatem sibi ex antiqua aliqua prosapia, per genealogiarum favores, astruunt et affingunt. Nos vero rerum evidentia freti, omnem commenti et imposturae conditionem rejicimus; neque ad id quod agitur plus interesse putamus, utrum quae jam invenientur antiquis olim cognita, et per rerum vicissitudines et

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Effectus impediret ne segnis mora,
Finxere antiqui talem effigiem temporis.'

Mr. Kitchin quotes also a hexameter found in Dionysius Cato, Distich. de Moribus, ii. 26 (circ. A. D. 400):

'Fronte capillata, post est Occasio calva.'

Cp. our proverb, 'Taking Time by the forelock.'

[43] This story is told of Philip of Macedon by Plutarch, Apophthegmata, p. 179. 25–29, ed. Reiske, vol. vi.: *Πρεσβύτιδος δὲ πενιχρᾶς ἀξιούσης ἐπ' αὐτοῦ κριθῆναι, καὶ πολλάκις ἐνοχλούσης, ἔφη, μὴ σχολάζειν. ἡ δὲ πρεσβύτις ἐγκραγοῦσα, Καὶ μὴ βασίλευε, εἶπεν. ὁ δὲ θαυμάσας τὸ ῥηθὲν, οὐ μόνον ἐκείνης, ἀλλὰ καὶ τῶν ἄλλων, εὐθὺς διήκουσεν.*

[44] Mr. Spedding suggests that 'occurrit' is a misprint for 'occurret.' Aphs. 122–126 contain the answers to four objections. Aph. 127 is the answer to a doubt rather than to an objection.

saecula occidentia et orientia sint, quam hominibus curae esse debere, utrum Novus Orbis fuerit insula illa Atlantis[45] et veteri mundo cognita, an nunc primum reperta. Rerum enim inventio a naturae luce petenda, non ab antiquitatis tenebris repetenda est.

Quod vero ad universalem istam reprehensionem attinet, certissimum est vere rem reputanti, eam et magis probabilem esse et magis modestam, quam si facta fuisset ex parte. Si enim in primis notionibus errores radicati non fuissent, fieri non potuisset quin nonnulla recte inventa alia perperam inventa correxissent. Sed cum errores fundamentales fuerint, atque ejusmodi, ut homines potius res neglexerint ac praeterierint, quam de illis pravum aut falsum judicium fecerint; minime mirum est, si homines id non obtinuerint quod non egerint, nec ad metam pervenerint quam non posuerint aut collocarint, neque viam emensi sint quam non ingressi sint aut tenuerint[46].

Atque insolentiam rei quod attinet; certe si quis manus constantia atque oculi vigore lineam magis rectam aut circulum magis perfectum se describere posse quam alium quempiam sibi assumat, inducitur scilicet facultatis comparatio: quod si quis asserat se adhibita regula aut circumducto circino lineam magis rectam aut circulum magis perfectum posse describere, quam aliquem alium vi sola oculi et manus, is certe non admodum jactator fuerit. Quin hoc, quod dicimus, non solum in hoc nostro conatu primo et incoeptivo locum habet; sed etiam pertinet ad eos qui huic rei posthac incumbent. Nostra enim via inveniendi scientias exaequat fere ingenia[47], et non multum excellentiae

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[45] See Plato's Timaeus, 24 E–25 D.

[46] Cp. Aph. 32.

[47] Cp. Aph. 61 and note 12. This anticipation of Bacon never has been, and never can be, realised. There is not, and there never can be, a mechanical method of invention, furnishing rules whereby men may invent arts or make discoveries with the same facility and certainty with which they use a pair of compasses. The reason of this impossibility is to be sought not only in the complexity and 'subtlety' of nature (which Bacon thought to be much simpler than it is) and in the laborious and complicated character of many of the processes of reasoning, but also in the important and, indeed, indispensable share which imagination has in all scientific discovery. Now for the stimulation and exercise of the imagination no rules can be given, though the habitual observation of the ordinary rules

eorum relinquit: cum omnia per certissimas regulas et demonstrationes transigat. Itaque haec nostra (ut saepe diximus) foelicitatis cujusdam sunt potius quam facultatis, et potius temporis partus quam ingenii. Est enim certe casus aliquis non minus in cogitationibus humanis, quam in operibus et factis.

CXXIII.

Itaque dicendum de nobis ipsis quod ille[48] per jocum dixit, praesertim cum tam bene rem secet: *fieri non potest ut idem sentiant, qui aquam et qui vinum bibant.* At caeteri homines, tam veteres quam novi, liquorem biberunt crudum in scientiis, tanquam aquam vel sponte ex intellectu manantem, vel per dialecticam, tanquam per rotas ex puteo, haustam. At nos liquorem bibimus et propinamus ex infinitis confectam uvis, iisque maturis et tempestivis, et per racemos quosdam collectis ac decerptis, et subinde in torculari pressis, ac postremo in vase repurgatis et clarificatis. Itaque nil mirum si nobis cum aliis non conveniat.

CXXIV.

Occurret proculdubio et illud: nec metam aut scopum scientiarum a nobis ipsis (id quod in aliis reprehendimus) verum et optimum praefixum esse. Esse enim contemplationem veritatis omni operum utilitate et magnitudine digniorem et celsiorem: longam vero istam et sollicitam moram in experientia et materia

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of logic, and especially of hypothesis, may be useful in diverting it from improper, and directing it into proper channels.

Bacon's confidence in the ease and certainty with which his method might be applied was a direct consequence of his theory of 'simple natures.' 'This method of exclusion' (says Mr. Ellis, E. and S., vol. i. pp. 33–6) 'requires only an attentive consideration of each "instantia," in order first to analyse it into its simple natures, and secondly to see which of the latter are to be excluded—processes which require no higher faculties than ordinary acuteness and patient diligence. There is clearly no room in this mechanical procedure for the display of subtlety or of inventive genius. Bacon's method therefore leads to certainty, and may be employed with nearly equal success by all men who are equally diligent.'

[48] Said by Philocrates of Demosthenes: *ἐπαναστὰς δ' ὁ Φιλοκράτης μάλα ὑβριστικῶς οὐδέν, ἔφη, θαυμαστόν, ὦ ἄνδρες Ἀθηναῖοι, μὴ ταὐτὰ ἐμοὶ καὶ Δημοσθένει δοκεῖν· οὗτος μὲν γὰρ ὕδωρ, ἐγὼ δὲ οἶνον πίνω. καὶ ὑμεῖς ἐγελᾶτε.* Demosth. De Falsa Legatione, p. 355.

et rerum particularium fluctibus mentem veluti humo affigere, vel potius in Tartarum quoddam confusionis et perturbationis dejicere; atque ab abstractae sapientiae serenitate et tranquillitate (tanquam a statu multo diviniore) arcere et summovere. Nos vero huic rationi libenter assentimur; et hoc ipsum, quod innuunt ac praeoptant, praecipue atque ante omnia agimus. Etenim verum exemplar mundi in intellectu humano fundamus; quale invenitur, non quale cuipiam sua propria ratio dictaverit. Hoc autem perfici non potest, nisi facta mundi dissectione atque anatomia diligentissima. Modulos vero ineptos mundorum et tanquam simiolas[49], quas in philosophiis phantasiae hominum extruxerunt, omnino dissipandas edicimus. Sciant itaque homines (id quod superius[50] diximus) quantum intersit inter humanae mentis *idola* et divinae mentis ideas. Illa enim nihil aliud sunt quam abstractiones ad placitum: hae autem sunt vera signacula Creatoris super creaturas, prout in materia per lineas veras et exquisitas imprimuntur et terminantur. Itaque ipsissimae res[51] sunt (in hoc genere) veritas et utilitas: atque opera ipsa pluris facienda sunt, quatenus sunt veritatis pignora, quam propter vitae commoda[52].

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[49] 'Apings,' 'mimicries.' The word is not classical, though simiolus is.

[50] Aph. 23.

[51] 'Therefore, the very things themselves (that is, the facts of nature) are, in this kind of enquiry, both truth and utility.' He means that, if we know the facts of nature, as they really are, we shall both attain truth and gain rules for practice. Mr. Spedding thinks that, if this were the true interpretation, we ought to have *et* before *veritas* as well as before *utilitas*. He proposes the translation 'truth and utility are (in this kind) the very same things,' though he acknowledges that this use of *ipsissimae* cannot be justified. To me there appears less difficulty in taking the passage as I have done above. Mr. Ellis proposes to render it thus: 'Truth and utility are in this kind the very things we seek for.' Mr. Kitchin, to the same effect, translates: 'And so the chief things of all are, in this kind, Truth and Usefulness.' This gives an excellent sense; but will the words bear it?

[52] We have here an important modification of the point of view which is prominent in Aph. 81. 'Veritas et utilitas,' and 'veritas' rather than 'utilitas' is, in this Aphorism, described as the proper and adequate object of the Baconian method. Cp. Aph. 129, where Bacon repeats, perhaps still more unequivocally, the same sentiment.

The following passages, which are quoted by Mr. Spedding, appear to me to be less in accordance with the spirit of this Aphorism than with that of Aph. 81, which, it must be acknowledged, is, notwithstanding many

CXXV.

Occurret fortasse et illud: nos tanquam actum agere, atque antiquos ipsos eandem quam nos viam tenuisse[53]. Itaque verisimile putabit quispiam etiam nos, post tantum motum et molitionem, deventuros tandem ad aliquam ex illis philosophiis quae apud antiquos valuerunt. Nam et illos in meditationum suarum principiis vim et copiam magnam exemplorum et particularium paravisse, atque in commentarios per locos et titulos digessisse, atque inde philosophias suas et artes confecisse, et postea, re comperta, pronuntiasse, et exempla ad fidem et docendi lumen sparsim addidisse; sed particularium notas et codicillos ac commentarios suos in lucem edere supervacuum

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expressions to the contrary, representative of Bacon's general attitude on this subject:

'Ista autem duo pronuntiata, Activum et Contemplativum, res eadem sunt; et quod in operando utilissimum, id in sciendo verissimum.' Nov. Org. ii. 4.

'Si quis autem sit, cui in contemplationis amorem et venerationem effuso, ista operum frequens et cum tanto honore mentio quiddam asperum et ingratum sonet, is pro certo sciat, se propriis desideriis adversari; etenim in natura, opera non tantum vitae beneficia, sed et veritatis pignora esse. Et quod in religione verissime requiritur, ut fidem quis ex operibus monstret; idem in naturali philosophia competere, ut scientia similiter ex operibus monstretur. Veritatem enim per operum indicationem, magis quam ex argumentatione aut etiam ex sensu, et patefieri et probari. Quare unam eandemque rationem et conditionis humanae et mentis dotandae esse.'—Cogitata et Visa, E. and S., vol. iii. p. 612.

'Quinetiam illis quibus in contemplationis amorem effusis frequens apud nos operum mentio asperum quiddam atque ingratum et mechanicum sonat, monstrabimus quantum illi desideriis suis propriis adversentur; cum puritas contemplationum atque substructio et inventio operum prorsus eisdem rebus nitantur, ac simul perficiantur.'—Partis Secundae Delineatio, E. and S., vol. iii. p. 549.

To these passages might be added Nov. Org. ii. 49: 'Etenim ipsum *Posse* et ipsum *Scire* naturam humanam amplificant, non beant. Itaque decerpenda sunt ex universitate rerum ea quae ad usus vitae maxime faciunt.'

In my notes on Aph. 81, I have already stated my reasons for regarding Bacon's conception of the ends of knowledge, or, at least, that which is most prominent in his works, as partial and insufficient. In a few places, however, as in the present Aphorism, he rises above the merely practical view, to which he usually attaches himself.

[53] Cp. Filum Labyrinthi, sive Inquisitio Legitima de Motu, E. and S., vol. iii. pp. 637–8.

et molestum putasse: ideoque fecisse quod in aedificando fieri solet, nempe post aedificii structuram machinas et scalas a conspectu amovisse. Neque aliter factum esse credere certe oportet. Verum nisi quis omnino oblitus fuerit eorum quae superius dicta sunt, huic objectioni (aut scrupulo potius) facile respondebit. Formam enim inquirendi et inveniendi apud antiquos et ipsi profitemur[54], et scripta eorum prae se ferunt. Ea autem non alia fuit[55], quam ut ab exemplis quibusdam et particularibus (additis notionibus communibus, et fortasse portione nonnulla ex opinionibus receptis, quae maxime placuerunt) ad conclusiones maxime generales sive principia scientiarum advolarent, ad quorum veritatem immotam et fixam conclusiones inferiores per media educerent ac probarent; ex quibus artem constituebant. Tum demum si nova particularia et exempla mota essent et adducta quae placitis suis refragarentur, illa aut per distinctiones aut per regularum suarum explanationes in ordinem subtiliter redigebant, aut demum per exceptiones grosso modo summovebant: at rerum particularium non refragantium causas ad illa principia sua laboriose et pertinaciter accommodabant. Verum nec historia naturalis et experientia illa erat, quam fuisse oportebat (longe certe abest), et ista advolatio ad generalissima omnia perdidit.

CXXVI.

Occurret et illud: nos, propter inhibitionem quandam pronuntiandi et principia certa ponendi donec per medios gradus ad generalissima rite perventum sit, suspensionem quandam judicii tueri, atque ad Acatalepsiam rem deducere. Nos vero non *Acatalepsiam*, sed *Eucatalepsiam*[56] meditamur et proponimus: sensui enim non derogamus, sed ministramus; et intellectum non contemnimus, sed regimus. Atque melius est

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[54] There can be no question that we ought to adopt Mr. Ellis' correction, 'profitentur.'

[55] The remainder of the Aphorism sums up and brings together what has already been said separately in many of the preceding Aphorisms.

[56] Mr. Kitchin appositely quotes the well-known passage from the Advancement of Learning: 'If a man will begin with certainties, he shall end in doubts; but if he will be content to begin with doubts, he shall end in certainties.' See Bk. i, E. and S., vol. iii. p. 293. Cp. Aph. 37.

scire quantum opus sit, et tamen nos non penitus scire putare, quam penitus scire nos putare, et tamen nil eorum quae opus est scire.

CXXVII.

Etiam dubitabit quispiam potius quam objiciet, utrum nos de Naturali tantum Philosophia[57], an etiam de scientiis reliquis, Logicis, Ethicis, Politicis, secundum viam nostram perficiendis loquamur[58]. At nos certe de universis haec quae

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[57] It will be noticed that Natural Philosophy is here used in its restricted sense, as opposed to 'scientiae logicae, ethicae,' &c., not as including the consideration of 'affectus et prehensiones intellectuales.' Cp. Aphs. 79, 80, where it is used in the wider sense.

[58] Cp. Newton's Optics, bk. ii. ad fin.: 'And if Natural Philosophy in all its parts, by pursuing this method, should at length be perfected, the bounds of Moral Philosophy will be also enlarged. For so far as we can know by Natural Philosophy what is the First Cause, what power he has over us, and what benefits we receive from him; so far our duty towards him, as well as that towards one another, will appear to us by the light of Nature.'

This Aphorism, notwithstanding certain passages in the Novum Organum which apparently point to the opposite conclusion, as, for instance, in the Preface, p. 183, and in Aphs. 29, 77, 128, affords conclusive evidence that Bacon contemplated the application of his method to the mental and moral, as well as the natural sciences. The extended meaning of the term 'Natural Philosophy' (including 'affectus et prehensiones intellectuales'), as employed in Aph. 80, appears to imply the same intention. And, though, perhaps, there is nothing in Bacon's works strictly corresponding to the 'historia et tabulae inveniendi de ira, metu,' &c., of which he speaks below, there are many places where he seems to assume that such enquiries fall within the scope of his philosophy. Besides the numerous passages in the later books of the De Augmentis, the student may refer to the Novum Organum, Bk. ii. Aphs. 26, 27, 35 ad fin., Historia Vitae et Mortis (E. and S., vol. ii. pp. 170–174), Filum Labyrinthi, sive Inquisitio Legitima de Motu, ad fin. (E. and S., vol. iii. pp. 639–40), Sylva Sylvarum, Exp. 795 and several of the 'experiments' in the tenth century. But, without multiplying references, I may state that it appears to me unquestionable that Bacon, while he regarded his method as primarily, and, perhaps, most easily applicable to the natural sciences, contemplated its ultimate extension to all branches of knowledge alike. The passages which seem to point in the opposite direction, are, I conceive, as I have already stated, ironical, and refer not to science, or knowledge in the true sense, at all, but to rhetoric and disputation.

On the justness of Bacon's view and on the sense or senses in which Induction is applicable to the moral and mental sciences, this is not the place to speak. It may suffice to say that, in my opinion, certainty can

dicta sunt intelligimus: atque quemadmodum vulgaris logica, quae regit res per syllogismum, non tantum ad naturales, sed ad omnes scientias pertinet; ita et nostra, quae procedit per *inductionem*, omnia complectitur. Tam enim historiam et tabulas [59] inveniendi conficimus de ira, metu, et verecundia, et similibus; ac etiam de exemplis rerum civilium: nec minus de motibus mentalibus memoriae, compositionis et divisionis [60], judicii, et reliquorum, quam de calido et frigido, aut luce, aut vegetatione, aut similibus. Sed tamen cum nostra ratio *interpretandi*, post historiam praeparatam et ordinatam, non mentis tantum motus et discursus (ut logica vulgaris), sed et

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only be attained in these sciences by the employment, at all events in the first instance, of the Inductive Method. Speculations, in these as in all other subjects, unless based on the patient study of facts, 'variantur, non augentur.' The enormous extension which the method of Induction has received in recent times by the application of a historical treatment to the subjects of law, institutions, language, art, morals, religion, &c., has really laid the basis of a scientific study of man, which may at some future time rival in respect of certainty, while it will even transcend in interest, the scientific study of nature. The student who may wish to see successful examples of this mode of treatment, the *historical method*, as it has been called, is referred to the works of Sir H. Maine, Professor Max Müller, Sir J. Lubbock, Mr. Tylor, and (though here, perhaps, he will be treading on less firm ground) to the Psychology and Sociology of Mr. Herbert Spencer. For an analysis of the historical method, he may consult the Editor's Inductive Logic, 3rd ed., pp. 200–202, and Mill's Logic, bk. vi. ch. 10. The whole of the sixth book of Mr. Mill's Logic bears on the methods of the moral and mental sciences.

The word 'logicis' in the above sentence should probably be taken as including what we call 'psychology' as well as logic proper. But even logic, in the strictest sense of the term, rests ultimately on an inductive basis. It is only through having observed what processes of reasoning lead to a sound, and what to an unsound conclusion, that is, to a conclusion agreeing or disagreeing with facts, that men have been able to frame with any certainty even the rules of logic itself.

[59] See last note.

[60] Affirmation and Negation, not, as Mr. Ellis suggests, Synthesis and Analysis. See Aldrich's Logic, ad init.: 'Est enim Judicium aliud *Affirmativum*, quod vocatur etiam *Compositio*; aliud *Negativum*, quod et *Divisio*.' This terminology is derived from Aristotle. Cp., for instance, De Interpretatione, ch. i: *περὶ γὰρ σύνθεσιν καὶ διαίρεσίν ἐστι τὸ ψεῦδός τε καὶ τὸ ἀληθές. τὰ μὲν οὖν ὀνόματα αὐτὰ καὶ τὰ ῥήματα ἔοικε τῷ ἄνευ συνθέσεως καὶ διαιρέσεως νοήματι, οἷον τὸ ἄνθρωπος ἢ τὸ λευκόν, ὅταν μὴ προστεθῇ τι· οὔτε γὰρ ψεῦδος οὔτε ἀληθές πω.*

rerum naturam intueatur; ita mentem regimus, ut ad rerum naturam se, aptis per omnia modis, applicare possit [61]. Atque propterea multa et diversa in doctrina *interpretationis* praecipimus, quae ad subjecti, de quo inquirimus, qualitatem et conditionem, modum inveniendi nonnulla ex parte applicent.

CXXVIII.

At illud de nobis ne dubitare quidem fas sit; utrum nos philosophiam et artes et scientias quibus utimur destruere et demoliri cupiamus: contra enim, earum et usum et cultum et honores libenter amplectimur. Neque enim ullo modo officimus, quin istae, quae invaluerunt, et disputationes alant, et sermones ornent, et ad professoria munera ac vitae civilis compendia adhibeantur et valeant; denique, tanquam numismata quaedam, consensu inter homines recipiantur. Quinetiam significamus aperte, ea quae nos adducimus ad istas res non multum idonea futura; cum ad vulgi captum deduci omnino non possint, nisi per effecta et opera tantum [62]. At hoc ipsum, quod de affectu nostro et bona voluntate erga scientias receptas dicimus, quam vere profiteamur, scripta nostra in publicum edita (praesertim libri *De Progressu Scientiarum* [63]) fidem faciant. Itaque id verbis amplius vincere non conabimur. Illud interim constanter et diserte

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[61] The object of this remark is to distinguish his own from the vulgar logic. The common logic is concerned only with the operations of the mind, regarded in and for themselves, but the Baconian logic has for its aim to interpret the ways of external nature as well as the processes of the human mind, and hence it must adapt and accommodate itself to the quality and condition of the various objects which it investigates. This is a far-seeing description of the office and peculiarities of the Inductive Logic. Thus, for example, one method or combination of methods is applicable to mechanical problems, another to the problems of chemistry, a third to those of physiology, and so on. Bacon's own 'Praerogativae Instantiarum' in the 2nd Book would afford a good instance of what he means.

[62] See notes on the last Aphorism and on Aph. 29. In favour of my interpretation of this and similar passages as ironical, I may adduce the argument that Bacon could hardly have contradicted himself on so important a matter in two consecutive Aphorisms.

[63] 'The Twoo Bookes of Francis Bacon of the Proficience and Advancement of Learning Divine and Humane,' first published in 1605. The De Augmentis, of course, was not yet published.

monemus; his modis, qui in usu sunt, nec magnos in scientiarum doctrinis et contemplatione progressus fieri, nec illas ad amplitudinem operum deduci posse.

CXXIX.

Superest ut de Finis excellentia pauca dicamus. Ea si prius dicta fuissent, votis similia videri potuissent: sed spe jam facta, et iniquis praejudiciis sublatis, plus fortasse ponderis habebunt. Quod si nos omnia perfecissemus et plane absolvissemus, nec alios in partem et consortium laborum subinde vocaremus, etiam ab hujusmodi verbis abstinuissemus, ne acciperentur in praedicationem meriti nostri. Cum vero aliorum industria acuenda sit et animi excitandi atque accendendi, consentaneum est ut quaedam hominibus in mentem redigamus.

Primo itaque, videtur inventorum nobilium introductio inter actiones humanas longe primas partes tenere: id quod antiqua saecula judicaverunt. Ea enim rerum inventoribus divinos honores tribuerunt[64]; iis autem qui in rebus civilibus merebantur (quales erant urbium et imperiorum conditores, legislatores, patriarum a diuturnis malis liberatores, tyrannidum debellatores, et his similes), heroum tantum honores decreverunt. Atque certe si quis ea recte conferat, justum hoc

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[64] Cp. De Augmentis, lib. i, E. and S., vol. i. p. 470: 'Quippe supra humanos honores, heroïci numerabantur et divini; in quorum distributione hunc ordinem tenuere veteres. Rerumpublicarum conditores, legislatores, tyrannicidae, patres patriae, quique in rebus civilibus optime meruerunt, insigniti sunt titulo Heroum tantum, aut Semideorum; quales fuere Theseus, Minos, Romulus, ceterique. Ex altera parte inventores et authores novarum artium, quique vitam humanam novis commodis et accessionibus dotarunt, semper consecrati sunt inter Deos ipsos Majores; quod Cereri, Baccho, Mercurio, Apollini, et aliis contigit. Quod certe jure et sano cum judicio factum est. Nam priorum benemerita intra unius aetatis aut nationis limites fere coërcentur; nec absimilia sunt imbribus tempestivis et benignis, qui quamvis frugiferi sint atque optabiles, tamen pro illa tempestate tantum qua decidunt, atque pro amplitudine tractus terrae quam irrigant, utiles sunt; posteriorum vero beneficia, ut ipsius solis et coelestium munera, temporibus perpetua, locis infinita sunt. Illa rursus cum contentione et perturbatione ut plurimum conjuncta sunt; haec habent verum characterem Divinae Praesentiae, veniuntque in *aura leni*, absque tumultu aut strepitu.'

prisci saeculi judicium reperiet. Etenim inventorum beneficia ad universum genus humanum pertinere possunt, civilia ad certas tantummodo hominum sedes: haec etiam non ultra paucas aetates durant, illa quasi perpetuis temporibus. Atque status emendatio in civilibus non sine vi et perturbatione plerumque procedit: at inventa beant, et beneficium deferunt absque alicujus injuria aut tristitia.

Etiam inventa quasi novae creationes sunt, et divinorum operum imitamenta; ut bene cecinit ille:

> 'Primum frugiferos foetus mortalibus aegris
> Dididerant quondam praestanti nomine Athenae;
> Et RECREAVERUNT vitam, legesque rogarunt[65].'

Atque videtur notatu dignum in Solomone; quod cum imperio, auro, magnificentia operum, satellitio, famulitio, classe insuper, et nominis claritate, ac summa hominum admiratione floreret, tamen nihil horum delegerit sibi ad gloriam, sed ita pronuntiaverit: *Gloriam Dei esse, celare rem; gloriam regis, investigare rem*[66].

Rursus (si placet) reputet quispiam, quantum intersit inter hominum vitam in excultissima quapiam Europae provincia, et in regione aliqua Novae Indiae[67] maxime fera et barbara: ea[68] tantum differre existimabit, ut merito *hominem homini Deum esse*[69], non solum propter auxilium et beneficium, sed

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[65] Lucretius, vi. 1–3. Bacon, in quoting these lines, probably from memory, has altered 'primae' into 'primum,' 'dididerunt' into 'dididerant,' and 'praeclaro' into 'praestanti.'

[66] Proverbs xxv. 2.

[67] The name given to the Western Continent and Islands, when first discovered by Columbus, who imagined them to be a part of India. We still have traces of this nomenclature in the 'West Indies,' the 'Red Indians,' 'Indiana,' &c.

[68] Ought not this word to be corrected to eas, which is the reading in the edition published at Leyden in 1645?

[69] '"Homo homini Deus, si suum officium sciat." An Aphorism of Caecilius Comicus apud Symmach. Epist. x. 104 (al. 114).' (? ix. 108.) 'Bacon has expanded the meaning of the saying (according to his wont) beyond its original extent. See also Zenobius, Cent. i. 91 in Gaisford's Paroemiographi Graeci, where the proverb is "Ἄνθρωπος ἀνθρώπου δαιμόνιον.' Mr. Kitchin's note. Of the two authors here cited, Caecilius Statius, the comic poet, died B.C. 168, being an immediate predecessor of Terence; Zenobius lived in the time of Hadrian. It has been pointed out to me that

etiam per status comparationem, recte dici possit. Atque hoc non solum, non coelum, non corpora, sed artes praestant.

Rursus, vim et virtutem et consequentias rerum inventarum notare juvat; quae non in aliis manifestius occurrunt, quam in illis tribus quae antiquis incognitae, et quarum primordia, licet recentia, obscura et ingloria sunt: Artis nimirum Imprimendi, Pulveris Tormentarii, et Acus Nauticae[70]. Haec enim tria rerum faciem et statum in orbe terrarum mutaverunt: primum, in re literaria; secundum, in re bellica; tertium, in navigationibus: unde innumerae rerum mutationes sequutae sunt; ut non imperium aliquod, non secta, non stella, majorem efficaciam et quasi influxum super res humanas exercuisse videatur, quam ista mechanica exercuerunt.

Praeterea non abs re fuerit, tria hominum ambitionis genera et quasi gradus distinguere. Primum eorum, qui propriam potentiam in patria sua amplificare cupiunt; quod genus vulgare est et degener. Secundum eorum, qui patriae potentiam et imperium inter humanum genus amplificare nituntur; illud plus certe habet dignitatis, cupiditatis haud minus. Quod si quis humani generis ipsius potentiam et imperium in rerum universitatem instaurare et amplificare conetur, ea proculdubio ambitio (si modo ita vocanda sit) reliquis et sanior est et augustior. Hominis autem imperium in res, in solis artibus et scientiis ponitur. Naturae enim non imperatur, nisi parendo[71].

Praeterea, si unius alicujus particularis inventi utilitas ita homines affecerit, ut eum qui genus humanum universum beneficio aliquo devincire potuerit homine majorem putaverint; quanto celsius videbitur tale aliquid invenire, per quod alia omnia expedite inveniri possint? Et tamen (ut verum om-

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the same proverb is referred to in Hooker's Ecclesiastical Polity, bk. i. See an interesting note on the passage in Dean Church's edition, p. 128, and cp. Jeremy Taylor's Works (ed. Heber and Eden), vol. iv. p. 315.

[70] Cp. Aph. 109.

[71] Cp. Aph. 3. Mr. Kitchin quotes Livy, xxi. 4, where, in describing Hannibal, he says: 'Nunquam ingenium idem ad res diversissimas, parendum atque imperandum, habilius fuit.' I may add Aristotle's description of the good citizen, Pol. iii. 4 (14): *δεῖ δὲ τὸν πολίτην τὸν ἀγαθὸν ἐπίστασθαι καὶ δύνασθαι καὶ ἄρχεσθαι καὶ ἄρχειν, καὶ αὕτη ἀρετὴ πολίτου, τὸ τὴν τῶν ἐλευθέρων ἀρχὴν ἐπίστασθαι ἐπ' ἀμφότερα.*

nino dicamus) quemadmodum luci magnam habemus gratiam, quod per eam vias inire, artes exercere, legere, nos invicem dignoscere possimus; et nihilominus ipsa visio lucis res praestantior est et pulchrior, quam multiplex ejus usus: ita certe ipsa contemplatio rerum prout sunt, sine superstitione aut impostura, errore aut confusione, in seipsa magis digna est, quam universus inventorum fructus [72].

Postremo, siquis depravationem scientiarum et artium ad malitiam et luxuriam et similia objecerit; id neminem moveat. Illud enim de omnibus mundanis bonis dici potest, ingenio, fortitudine, viribus, forma, divitiis, luce ipsa, et reliquis. Recuperet modo genus humanum jus suum in naturam quod ei ex dotatione divina competit, et detur ei copia: usum vero recta ratio et sana religio gubernabit.

CXXX.

Jam vero tempus est ut artem ipsam Interpretandi Naturam proponamus: in qua licet nos utilissima et verissima praecepisse arbitremur, tamen necessitatem ei absolutam (ac si absque ea nil agi possit) aut etiam perfectionem non attribuimus. Etenim in ea opinione sumus: si justam Naturae et Experientiae Historiam [73] praesto haberent homines, atque in ea sedulo versarentur, sibique duas res imperare possent; unam, ut receptas opiniones et notiones deponerent; alteram, ut mentem a generalissimis et proximis ab illis ad tempus cohiberent; fore ut etiam vi propria et genuina mentis [74], absque alia arte, in formam nostram Interpretandi incidere possent. Est enim *Interpretatio* verum et naturale opus mentis, demptis iis quae obstant [75]: sed tamen omnia certe

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[72] Cp. Aph. 124 ad fin. and note 51. This passage, like that, is a happy exception to the manner in which Bacon, when speaking of the ends of knowledge, usually subordinates truth to practice.

[73] This again shows the importance which Bacon attached to his Natural History. Cp. Aph. 98 and my notes on it.

[74] But the mind would, in that case, employ unconsciously the rules which Bacon and his successors have prescribed for its conscious use. 'Natural Logic' is only artificial logic, employed unconsciously, and artificial logic is only the formal expression of Natural Logic.

[75] Mr. Spedding compares the following parallel passages:—Valerius Terminus, ch. 22:—'That it is true that interpretation is the very natural

per nostra praecepta erunt magis in procinctu, et multo firmiora.

Neque tamen illis nihil addi posse affirmamus: sed contra, nos, qui mentem respicimus non tantum in facultate propria, sed quatenus copulatur cum rebus, Artem inveniendi cum Inventis adolescere posse, statuere debemus[76].

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and direct intention, action, and progression of the understanding, delivered from impediments; and that all anticipation is but a deflexion or declination by accident.' Adv. of Learn. (2nd book):—'For he that shall attentively observe how the mind doth gather this excellent dew of knowledge, like unto that which the poet speaketh of, *Aërii mellis coelestia dona*, distilling and contriving it out of particulars natural and artificial, as the flowers of the field and garden, shall find that the mind of herself by nature doth manage and act an induction much better than they describe it.'

[76] In the Cogitata et Visa (E. and S., vol. iii. p. 610), there is a fine passage on the relation between particular discoveries and the Art of Discovery itself:

'Quod si particularis alicujus inventi utilitas ita homines affecerit, ut eum qui universum genus humanum unico aliquo beneficio complecti posset, homine majorem putarent; at multo celsius inventum esse, quod alia omnia inventa particularia potentia quadam in se contineat, ac animae humanae vias aperiat, ut ad nova et ulteriora quaeque ductu certo et recto penetrare possit. Quemadmodum enim saeculis prioribus, cum homines in navigando per stellarum tantum observationes cursum dirigebant, eos veteris sane continentis oras legisse, aut maria aliqua minora et mediterranea trajecisse; necesse autem fuisse usum acus nauticae, ut ducem viae magis fidum, innotuisse, antequam Oceanus trajiceretur, et Novi Orbis regiones detegerentur: simili prorsus ratione, quae hucusque in artibus et scientiis hominum inventa sunt, potuisse instinctu, usu, observatione, meditatione, aperiri, utpote sensui propiora; antequam vero ad remotiora et occultiora naturae appellere liceat, necessario praecedere, ut melior et perfectior mentis humanae usus et adoperatio inveniatur. Quare hujuscemodi Inventum proculdubio Temporis partum nobilissimum, et vere masculum esse.'

M. Bouillet calls attention to the following passage in the Filum Labyrinthi, sive Inquisitio Legitima de Motu (E. and S., vol. iii. pp. 635–636): 'Nam et ipsi statuimus, artem inveniendi adolescere cum inventis; neque ad aliquid immotum et inviolabile inveniendi artificium hominum industriam et felicitatem astringendam. Artis enim perfectionem artis usum remorari, nihil est necesse.'

Properly speaking, there is no such art as an 'Art of Invention,' for 'invention' depends on the exercise of the imaginative faculty, which has

not hitherto been amenable, and is never likely to be amenable, to rules. But, at the same time, as we have seen in a note on a previous aphorism (Aph. 122), by the cultivation of logical habits of mind, and the habitual observation of certain rules, even the imagination may be diverted from improper, and directed into proper channels. Moreover, when imagination has played its part, its products must be submitted to and tested by reason, and here it becomes necessary to employ the rules of logic, whether such rules be stated formally, or, as is more frequently the case, applied unconsciously. At this point, then, arises the question (suggested by this and the latter part of the 127th Aphorism, q. v.), whether there is any advance in the analyses and rules of logic in any way corresponding to the advance which is constantly taking place in the individual sciences? On the whole, I think, it may be answered that there is. For what is Logic but the analysis of the most correct modes of reasoning in each department of human thought, and the construction of rules based on such analysis? Now reasoning is constantly being applied to new subjects or to new branches of old subjects; complicated cases of reasoning, too, are constantly being unravelled and referred to simple principles. Hence, though we are never likely to discover any new laws of thought or to add to the simple formulae to which all reasoning may be reduced in the last resort, yet we may be constantly gaining a wider knowledge of the applications, and possibly of the necessary modifications, of our rules, increased practical skill in weighing arguments and detecting fallacies, and a juster view of the special characteristics which distinguish the reasoning and method of each particular science. And that logic (in the largest sense of the term) has, as a matter of fact, advanced, as the particular arts and sciences have advanced, though not, perhaps, always in the same proportion, hardly admits, I conceive, of any doubt.

The dependence of Logic on the condition of the several sciences is put in a striking, though undoubtedly an exaggerated, form by Condillac (Histoire Moderne, livre xx. ch. 12): 'Je n'ai pas le courage de vous parler de ceux qui, avant le renouvellement des sciences, ont tenté d'enseigner l'art de raisonner. Si des Tartares voulaient faire une poétique, vous pensez bien qu'elle serait mauvaise, parce qu'ils n'ont pas de bons poëtes. Il en est de même des logiques qui ont été faites avant le dix-septième siècle.'

LIBER
SECUNDUS
APHORISMORUM.

SUMMARY OF BOOK II.

FROM the prefatory remarks of Book I, Bacon passes in Book II to a more formal and positive exposition of his method. The first ten Aphorisms consist mainly of general reflections, for the most part very obscurely worded, on the ends of science, on the necessity of enquiring into Forms, and on the connection between the speculative and practical branches of knowledge. He then proceeds to give a specimen of the investigation of a Form, taking as his example the Form of Heat. The first step in the investigation is to draw up certain Tables, the ultimate purpose of which is to enable him to eliminate those qualities which might be supposed to be, but which are not really, of the required Form. When the Tables are completed, and the false explanations have, so far as possible, been rejected, he proceeds, according to his own metaphor, to reap the 'Vindemiatio Prima de forma Calidi,' and, in order to reap this vintage, he gives free play to the Imagination, that is, in spite of his warnings to the contrary in Book I, he frames Hypotheses. This process is called 'permissio intellectus.' 'Atque haec sit prima vindemiatio, sive interpretatio inchoata de forma Calidi, facta per permissionem intellectus' (see Aph. 20). In Aph. 21 he announces that, having completed the 'Tabulae' and 'Vindemiatio Prima,' he will proceed 'ad reliqua auxilia intellectus circa Interpretationem Naturae et Inductionem veram ac perfectam.' Of these 'auxilia' he enumerates nine (Aph. 21), but of the nine one only, the 'Praerogativae Instantiarum' (of which there are twenty-seven varieties), are discussed in the Fragment of the Novum Organum which Bacon published. He is on the point of passing on to the 'adminicula inductionis,' when the work abruptly ends.

LIBER SECUNDUS

APHORISMORUM

DE INTERPRETATIONE

NATURAE,

SIVE

DE REGNO

HOMINIS.

APHORISMUS.

I.

SUPER datum corpus novam naturam[1] sive novas naturas generare et superinducere, opus et intentio est humanae potentiae[2]. Datae autem naturae Formam, sive differentiam veram[3], sive naturam naturantem[4], sive fontem emanationis

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[1] Mr. Ellis remarks that, throughout this Aphorism, Bacon maintains the antithesis between 'corpus,' the concrete body, and 'natura,' the abstract quality. Of each 'corpus' various 'naturae' are predicable.

[2] Bacon seems to have thought that, if we could once discover the 'form,' we could superinduce it on any given body, but this by no means follows. Suppose we knew the exact 'form' of the 'natures' which are predicable of and constitute gold, could we superinduce these on silver, or could we eliminate the 'natures' which characterise silver and substitute those which characterise gold?

[3] Its distinguishing characteristics, or, more precisely, its essence, or inmost constitution, or fundamental attributes.

[4] In the most general meaning of the words, Natura Naturans and Natura Naturata may be described as related to each other in the following manner. Natura Naturata is the actual condition of a given object or

(ista enim vocabula habemus, quae ad indicationem rei proxime accedunt) invenire, opus et intentio est humanae scientiae[5]. Atque his operibus primariis subordinantur alia opera duo secundaria et inferioris notae; priori, transformatio corporum concretorum de alio in aliud, intra terminos Possibilis[6]; posteriori, inventio in omni generatione et motu *latentis processus*[7], continuati ab efficiente manifesto et materia mani-

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quality, or of the aggregate of all objects and qualities, the Universe, at any given time; Natura Naturans is the immanent cause of this condition, or aggregate of conditions, and is regarded as producing it by a continuous process. Thus, when we say 'how wonderfully Nature works,' we are speaking of 'Natura Naturans;' when we say 'how beautiful is Nature,' we are speaking of Natura Naturata. Hence, Natura Naturans is related to Natura Naturata as cause to effect. Or, again, we may say that Natura Naturans is the active or dynamical, Natura Naturata the passive or statical aspect of Nature. It will be easily understood from this account how Natura Naturans, in some systems of philosophy, as, for instance, in that of Spinoza, came to denote God as the immanent cause of the Universe.

In employing 'natura naturans' and 'fons emanationis' as the equivalents of 'form,' Bacon seems to be adopting a point of view slightly different from that which he takes, where he describes it as 'vera differentia.' But, perhaps, we may exhibit the identity of these various expressions, by saying that the 'data natura' results from the 'form' in the same way that the secondary properties flow from the primary ('differentia vera'), or the attributes from the substance, or effects in nature from the indwelling cause. I am, however, inclined to think that in this passage the word 'form' is really employed, though, of course, unconsciously, with two different shades of meaning, namely, as the equivalent of 'essence' ('differentia vera') and of 'cause' ('natura naturans, sive fons emanationis'). For an explanation of these two meanings, and an attempt at reconciling them, see Introduction, § 8.

[5] For the connection between 'scientia et potentia humana,' cp. Bk. i. Aph. 3.

[6] The idea of the transmutation of one body into another, and specially of metals, is of frequent occurrence in Bacon's works, and is specially insisted on in Liebig's invective against the Baconian philosophy. 'The *possibility*,' says Mr. Ellis, 'of transmutation, long and strenuously denied, though certainly on no sufficient grounds, is now generally admitted. "There was a time when this fundamental doctrine of the alchemists was opposed to known analogies. It is now no longer so opposed to them, only some stages beyond their present development." Faraday, Lectures on Non-Metallic Elements, p. 106.'

On Bacon's ideas as to the transmutability of the elements and of metals, the student may refer to the Introduction, pp. 26–28.

[7] See Aph. 6 and i. 51.

festa usque ad Formam inditam; et inventio similiter *latentis schematismi*[8] corporum quiescentium et non in motu.

II.

Quam infeliciter se habeat scientia humana, quae in usu est, etiam ex illis liquet quae vulgo asseruntur. Recte ponitur; *Vere scire, esse per causas scire*[9]. Etiam non male constituuntur causae quatuor; Materia, Forma, Efficiens, et Finis[10]. At ex his causa finalis tantum abest ut prosit, ut etiam scientias corrumpat, nisi in hominis actionibus[11]. Formae inventio habetur pro desperata[12]. Efficiens vero, et materia (quales quaeruntur et recipiuntur, remotae scilicet[13], absque *latenti*

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[8] See Aph. 7 and i. 51.

[9] Ἐπίστασθαι οἰόμεθα ὅταν τήν τ' αἰτίαν οἰώμεθα γινώσκειν, δι' ἣν τὸ πρᾶγμά ἐστιν, ὅτι ἐκείνου αἰτία ἐστί, καὶ μὴ ἐνδέχεσθαι τοῦτ' ἄλλως ἔχειν. Arist. An. Post. i. 2 ad init.

Whatever may be our opinion as to the nature of Causation, or the ultimate analysis of the idea of Cause, this maxim is undoubtedly true; we cannot truly know a thing, unless we know its antecedents and conditions.

[10] On the Four Causes of Aristotle, see Introduction, § 8, n. 30.

[11] In the actions of men, we must, of course, take account of Final Causes. We know by experience that men always or generally act, consciously or unconsciously, with some end in view. Hence, to understand their acts, we must enquire into their aims. It is from supposing that Nature always, in like manner, has some end in view, from an analogy, in fact, between man and nature, that the theory of Final Causes has been extended to Physics.

On the subject of Final Causes generally, and Bacon's criticism of the doctrine, see Introduction, § 10.

[12] Cp. Bk. i. Aph. 75.

[13] He is probably alluding here to the ὕλη, or shapeless matter, potentially all things and actually nothing, of the Aristotelians, and to the habit of referring natural events and processes to God or Nature as the First Cause, instead of seeking to ascertain the second and proximate Efficient Causes. The proximate efficient cause with Bacon would be the latens processus, and the proximate material cause the latens schematismus. A knowledge of these, he thought, would increase our power over nature, whereas the various speculations about the more remote causes appertained, he conceived, not to physics, but to metaphysics and theology.

The causes which he condemns as 'remote' and 'superficial' may, however, simply be the material and efficient causes, as popularly assigned. Thus, for instance, we might say that vegetable matter was the material cause of coal, and continued pressure its efficient cause. But Bacon would

processu ad formam) res perfunctoriae sunt, et superficiales, et nihili fere ad scientiam veram et activam. Neque tamen obliti sumus nos superius notasse et correxisse errorem mentis humanae, in deferendo formis primas essentiae [14]. Licet enim in natura nihil vere existat praeter corpora individua [15], edentia actus puros individuos ex lege; in doctrinis tamen, illa ipsa lex, ejusque inquisitio et inventio atque explicatio, pro fundamento est tam ad sciendum, quam ad operandum. Eam autem *legem*, ejusque *paragraphos* [16], formarum nomine intelligimus; praesertim cum hoc vocabulum invaluerit, et familiariter occurrat.

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insist on knowing its inmost structure and the secret process by which it had passed from its original condition into its present state.

[14] Sc. primas partes. The passage to which he alludes is undoubtedly Bk. i. Aph. 51, where the 'forms' which he condemns are apparently the ἰδέαι of Plato (cp. Bk. i. Aph. 65), and where he insists on the investigation of the matter rather than the form. 'Materia potius considerari debet, et ejus schematismi, et meta-schematismi, atque actus purus, et lex actus sive motus; formae enim commenta animi humani sunt, nisi libeat leges illas actus formas appellare.' Forms (in the sense of the Platonists and some of the Schoolmen), as abstracted from matter, Bacon rejected altogether; instead of being the principal constituents or the main ground of being ('primae partes essentiae'), he denied that they had any existence at all. His own 'forms,' whatever their precise character may have been, were to be arrived at only by an investigation of matter, and had no existence apart from matter. Hence, the opposition between form and matter had no place in his philosophy, and 'to assign to forms the principal share in being' became an unmeaning phrase.

[15] He is here again combating the Platonic and Scholastic Realism. Strictly speaking, there exist only individual bodies, with their individual manifestations. We may translate the next clause, 'giving forth individual manifestations (ἐνέργειαι) according to law.' The laws according to which individual bodies exhibit their various manifestations are the proper object of knowledge, and such knowledge is the only guide to practice.

This sentence, combined with Bk. i. Aph. 1, affords, perhaps, one of the best statements we have of the Nominalist, as opposed to the Realist, theory of the nature and objects of knowledge.

[16] 'Clauses' or 'sections.' I think that Mr. Ellis (see General Preface, p. 31) interprets this term rightly, in referring it to the 'simple natures' into which Bacon (see Bk. ii. Aph. 17) regarded the forms of substances as admitting of resolution. A 'forma copulata' (as of lion, gold, &c.) is a 'conjugium naturarum simplicium,' and hence the 'simple natures' may be regarded as 'clauses' of the forma copulata.

There would, however, be no difficulty in interpreting 'paragraphos' with reference to the 'forms' of the 'simple natures' themselves. The

III.

Qui causam alicujus naturae (veluti albedinis aut caloris) in certis [17] tantum subjectis novit; ejus scientia imperfecta est: et qui effectum super certas tantum materias (inter eas, quae sunt susceptibiles) inducere potest; ejus potentia pariter imperfecta est. At qui efficientem et materialem causam [18] tantummodo novit (quae causae fluxae sunt, et nihil aliud quam vehicula et causae formam deferentes in aliquibus [19]), is ad nova inventa, in materia aliquatenus simili et praeparata, pervenire potest; sed rerum terminos altius fixos non movet. At qui formas novit, is naturae unitatem in materiis dissimillimis complectitur [20]; itaque quae adhuc facta non sunt, qualia nec naturae vicissitudines, neque experimentales industriae, neque casus ipse, in actum unquam perduxissent, neque

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allusion would then be to the several differentiae which constitute, or the several conditions out of which is produced, the given nature, such, for instance, as those enumerated in Aph. 20.

It will be noticed that Bacon here employs the word 'Form' in a different sense (namely, the signification appropriated to it by himself) from that in which he employed it in the last sentence but one, where he condemned the position assigned to Forms.

[17] 'Certain' in the sense of 'particular.'

[18] The Efficient and Material Causes seem here to be spoken of only in reference to concrete substances, while the Forms which Bacon has in view in this Aphorism are those of 'simple natures,' such as heat or whiteness. Now he who knows the material and efficient causes of any given substance may be able to produce or modify other substances of a similar character, but his power will extend no further. But he, on the other hand, who is acquainted with the form, law, or cause of a 'simple nature,' such as heat or whiteness, will be able to produce it in substances of the most dissimilar kind.

[19] In particular substances only. The meaning is that the Efficient and Material Causes vary as we pass from one substance to another (fluxae sunt), and convey or embody the form in certain cases only. In other cases, a different efficient cause might be necessary to convey, or a different material cause to embody, the same form.

[20] Thus, if we knew the Law of the development of Heat, we should be able to produce heat in any substance whatever. This scientific knowledge of law is here contrasted with the merely empirical knowledge of the artisan, who, being acquainted with certain substances only, can produce changes in them, or like substances, but who, not being acquainted with the Laws of Nature, cannot extend his operations beyond the range of his experience.

cogitationem humanam subitura fuissent, detegere et producere potest. Quare ex formarum inventione sequitur contemplatio vera, et operatio libera [21].

IV.

Licet viae ad potentiam atque ad scientiam humanam conjunctissimae sint et fere eaedem, tamen propter perniciosam et inveteratam consuetudinem versandi in abstractis, tutius omnino est ordiri et excitare scientias ab iis fundamentis quae in ordine sunt ad partem activam, atque ut illa ipsa partem contemplativam signet et determinet. Videndum itaque est, ad aliquam naturam super corpus datum generandam et superinducendam, quale quis praeceptum aut qualem quis directionem aut deductionem maxime optaret; idque sermone simplici et minime abstruso.

Exempli gratia; si quis argento cupiat superinducere flavum colorem auri aut augmentum ponderis (servatis legibus materiae [22]), aut lapidi alicui non diaphano diaphaneitatem, aut vitro tenacitatem, aut corpori alicui non vegetabili vegetationem; videndum (inquam) est, quale quis praeceptum aut deductionem potissimum sibi dari exoptet. Atque primo, exoptabit aliquis proculdubio sibi monstrari aliquid hujusmodi, quod opere non frustret neque experimento fallat. Secundo, exoptabit quis aliquid sibi praescribi, quod ipsum non astringat et coerceat ad media quaedam et modos quosdam operandi particulares. Fortasse enim destituetur, nec habebit facultatem et commoditatem talia media comparandi et procurandi. Quod si sint et alia media et alii modi (praeter illud praeceptum) progignendae talis naturae, ea fortasse ex iis erunt quae sunt in operantis potestate; a quibus nihilominus per angustias praecepti excludetur, nec fructum capiet. Tertio, optabit aliquid sibi monstrari, quod non sit aeque difficile ac illa ipsa operatio de qua inquiritur, sed propius accedat ad praxin.

Itaque de praecepto vero et perfecto operandi, pronuntiatum

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[21] That is, unrestricted to this or that object-matter. Cp. again Bk. i. Aph. 3.

[22] Are not these words inserted in order to intimate that the process must be regarded as purely physical, and to exclude Superstitious Magic? Mr. Ellis explains: 'That is, with a corresponding decrease of volume.'

erit tale; *ut sit certum, liberum, et disponens*[23] *sive in ordine ad actionem.* Atque hoc ipsum idem est cum inventione formae verae. Etenim forma naturae alicujus talis est ut, ea posita, natura data infallibiliter[24] sequatur. Itaque adest perpetuo, quando natura illa adest[25], atque eam universaliter affirmat, atque inest omni. Eadem forma talis est ut, ea amota, natura data infallibiliter fugiat[26]. Itaque abest perpetuo, quando natura illa abest, eamque perpetuo abnegat, atque inest soli[27]. Postremo[28], forma vera talis est, ut

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[23] 'Auxiliary.'

[24] So far as 'Forma' here = cause, 'infallibiliter' must be taken with the qualification, 'unless there are counteracting circumstances.'

[25] So far as 'Forma' = cause, and 'natura illa' = effect, Bacon is open to the charge, made against him by Mill, of having neglected to take into consideration the fact of plurality of causes. The same cause (unless there are counteracting circumstances) always produces the same effect, but the same effect may be due to different causes, as, for instance, death to disease, poison, or a shot-wound. See Mill's Logic, bk. iii. ch. 10; bk. v. ch. 3. § 7. See also my Inductive Logic, 3rd Ed., pp. 6, 125, 127–30.

[26] See last note. The effect, in any particular instance, might be due to a different cause, and would, therefore, not disappear.

[27] 'Therefore, the form is always absent, when the given nature is absent' (this is true), 'and its absence always involves the absence of the given nature' (this is inaccurate; see above), 'and it is to be found in the given nature only' (this is true). My criticism, contained in the above parentheses, applies, of course, only to the case in which Form = cause.

[28] Here 'form' seems to be taken in the sense of 'vera differentia' (see Aph. 1). The 'fons essentiae' spoken of below is regarded as the genus, and the 'natura data' as the species or tota essentia. The last is supposed to be deduced from the fons essentiae by means of (or by the addition of) the form.

This passage is interesting, because it illustrates both the ambiguity of the word 'Form,' and the close approximation or even ultimate identity of its two meanings, as noticed in the Introduction, § 8. The 'Fons Essentiae' may be regarded as the original substance capable of differentiation, the 'natura data' as the new substance produced from it, and the 'form' either as the law governing the development of the one from the other or as the sum of the attributes which, added to the original 'essentia,' constitute the 'natura data.' Thus, let us suppose, for the sake of example, that it would be possible to find a menstruum, or common substance, capable, by the addition of various differentiae, of becoming gold, silver, copper, &c. The menstruum or common substance would represent the fons essentiae, and gold, silver, &c. the naturae datae. Then, we might describe the 'form' either as the *attributes* which, added to the menstruum, constitute the natura data, or as the *conditions* under which the natura

naturam datam ex fonte aliquo essentiae deducat quae inest pluribus, et notior est naturae[29] (ut loquuntur) quam ipsa forma. Itaque de axiomate vero et perfecto sciendi pronuntiatum et praeceptum tale est; *ut inveniatur natura alia, quae sit cum natura data convertibilis*[30], *et tamen sit limitatio naturae notioris, instar generis veri*[31]. Ista autem duo pronuntiata, activum et contemplativum, res eadem sunt; et quod in operando utilissimum, id in sciendo verissimum[32].

V.

At praeceptum sive axioma de transformatione corporum duplicis est generis[33]. Primum intuetur corpus, ut turmam

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data is developed from the menstruum, or, which is only another way of speaking, as the *law* of the process by which the menstruum is converted into the natura data.

[29] That is, more general. See note 27 on Bk. i. Aph. 22. The proper expression is natura notior.

[30] This expression requires qualification. See notes 25, 26 above.

[31] 'As of a true genus.' The 'genus verum' is the same as the 'natura notius' or 'fons essentiae.'

[32] See Bk. i. Aphs. 81, 129, with the notes.

[33] One of these modes of transformation proceeds by discovering the various simple natures or qualities which determine the character of the body, and then superinducing them one by one, till the body is constituted (cp. Sylva Sylvarum, Exp. 328); the other watches the latent process by which the body is produced according to the ordinary way of nature, and then attempts to repeat it artificially. The artificial production of marble by fusion under pressure would be a good instance of the latter mode of transformation, as well as the various attempts, more or less successful, to produce artificial diamonds. For Bacon's sanguine expectations as to the former mode, I cannot offer a better apology than that suggested by Mr. Mill (Logic, bk. v. ch. 3. § 7): 'Why should it not be possible to make gold? Each of the characteristic properties of gold has its *forma*, its essence, its set of conditions, which if we could discover, and learn how to realise, we could superinduce that particular property upon any other substance, upon wood, or iron, or lime, or clay. If, then, we could effect this with respect to every one of the essential properties of the precious metal, we should have converted the other substance into gold. Nor did this, if once the premises were granted, appear to transcend the real powers of mankind. For daily experience showed that almost every one of the distinctive sensible properties of any object, its consistence, its colour, its taste, its smell, its shape, admitted of being totally changed by fire, or water, or some other chemical agent. The *formae* of all those qualities seeming, therefore, to be within human power either to produce

sive conjugationem naturarum simplicium: ut in auro haec conveniunt; quod sit flavum; quod sit ponderosum, ad pondus tale; quod sit malleabile aut ductile, ad extensionem talem; quod non fiat volatile, nec deperdat de quanto suo per ignem; quod fluat fluore tali; quod separetur et solvatur modis talibus; et similiter de caeteris naturis, quae in auro concurrunt. Itaque hujusmodi axioma rem deducit ex formis naturarum simplicium. Nam qui formas et modos novit superinducendi flavi, ponderis, ductilis, fixi, fluoris, solutionum, et sic de reliquis, et eorum graduationes et modos, videbit et curabit ut ista conjungi possint in aliquo corpore, unde sequatur transformatio in aurum. Atque hoc genus operandi pertinet ad actionem primariam. Eadem enim est ratio generandi naturam unam aliquam simplicem, et plures; nisi quod arctetur magis et restringatur homo in operando, si plures requirantur, propter difficultatem tot naturas coadunandi; quae non facile conveniunt, nisi per vias naturae tritas et ordinarias. Utcunque tamen dicendum est, quod iste modus operandi (qui naturas intuetur simplices, licet in corpore concreto) procedat ex iis [34], quae in natura sunt constantia et aeterna et catholica, et latas praebeat potentiae humanae vias, quales (ut nunc sunt res) cogitatio humana vix capere aut repraesentare possit.

At secundum genus axiomatis (quod a *latentis processus* inventione pendet) non per naturas simplices procedit, sed per concreta corpora, quemadmodum in natura inveniuntur, cursu ordinario. Exempli gratia; in casu ubi fit inquisitio, ex quibus initiis, et quo modo, et quo processu, aurum aut aliud quodvis metallum aut lapis generetur, a primis menstruis aut rudimentis suis usque ad mineram perfectam; aut similiter, quo processu herbae generentur, a primis concretionibus succorum in terra, aut a seminibus, usque ad plantam formatam, cum universa illa successione motus, et diversis et continuatis naturae nixibus; similiter, de generatione ordinatim explicata animalium, ab initu ad partum; et similiter de corporibus aliis.

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or to annihilate, not only did the transmutation of substances appear abstractedly possible, but the employment of the power, at our choice, for practical ends, seemed by no means hopeless.'

[34] Sc. naturae simplices.

Enimvero neque ad generationes corporum tantum spectat haec inquisitio, sed etiam ad alios motus et opificia naturae. Exempli gratia; in casu ubi fit inquisitio de universa serie et continuatis actionibus alimentandi, a prima receptione alimenti ad assimilationem perfectam; aut similiter de motu voluntario in animalibus, a prima impressione imaginationis et continuatis nixibus spiritus usque ad flexiones et motus artuum; aut de explicato motu linguae et labiorum et instrumentorum reliquorum usque ad editionem vocum articulatarum. Nam haec quoque spectant ad naturas concretas, sive collegiatas et in fabrica; et intuentur veluti consuetudines naturae particulares et speciales, non leges fundamentales et communes, quae constituunt formas [35]. Veruntamen omnino fatendum est, rationem istam videri expeditiorem et magis sitam in propinquo, et spem injicere magis, quam illam primariam.

At pars Operativa similiter, quae huic parti Contemplativae respondet, operationem extendit et promovet ab iis quae ordinario in natura inveniuntur ad quaedam proxima, aut a proximis non admodum remota; sed altiores et radicales operationes super naturam pendent utique ab axiomatibus primariis. Quinetiam ubi non datur homini facultas operandi, sed tantum sciendi, ut in coelestibus (neque enim ceditur homini operari in coelestia, aut ea immutare aut transformare), tamen inquisitio facti ipsius sive veritatis rei, non minus quam cognitio causarum et consensuum, ad primaria illa et catholica axiomata de naturis simplicibus (veluti de natura rotationis spontaneae [36], attractionis sive virtutis magneticae, et aliorum complurium quae magis communia sunt quam ipsa coelestia) refertur. Neque enim speret aliquis terminare quaestionem, utrum in motu diurno revera terra aut coelum rotet, nisi naturam rotationis spontaneae prius comprehenderit.

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[35] In attempting to determine the meaning which Bacon attached to the word Form, this language is of some importance. The 'fundamental and common laws' seem to be distinguished from the 'forms' or simple natures which they 'constitute,' and thus one 'law' or 'form' to be regarded as more generic than another. See Introduction, p. 61.

[36] See ii. 36 (2) and 48 (17), with notes.

VI.

Latens autem *Processus*[37], de quo loquimur, longe alia res est quam animis hominum (qualiter nunc obsidentur) facile possit occurrere. Neque enim intelligimus mensuras quasdam, aut signa, aut scalas processus in corporibus spectabiles; sed plane processum continuatum, qui maxima ex parte sensum fugit.

Exempli gratia; in omni generatione et transformatione corporum, inquirendum quid deperdatur et evolet, quid maneat, quid accedat; quid dilatetur, quid contrahatur; quid uniatur, quid separetur; quid continuetur, quid abscindatur; quid impellat, quid impediat; quid dominetur, quid succumbat; et alia complura.

Neque hic rursus, haec tantum in generatione aut transformatione corporum quaerenda sunt; sed et in omnibus aliis alterationibus et motibus similiter inquirendum quid antecedat, quid succedat; quid sit incitatius, quid remissius; quid motum praebeat, quid regat; et hujusmodi. Ista vero omnia scientiis (quae nunc pinguissima Minerva et prorsus inhabili contexuntur) incognita sunt et intacta. Cum enim omnis actio naturalis per minima[38] transigatur, aut saltem per illa quae

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[37] See Playfair's Preliminary Dissertation to the Encyclopaedia Britannica, Remarks on the Novum Organum: 'Latent Process is the secret and invisible progress by which sensible changes are brought about, and seems, in Bacon's acceptation, to involve the principle, since called the *law of continuity*, according to which, no change, however small, can be effected but in *time*. To know the relation between the time and the change effected in it, would be to have a perfect knowledge of the latent process. In the firing of a cannon, for example, the succession of events during the short interval between the application of the match and the expulsion of the ball, constitutes a latent process of a very remarkable and complicated nature, which, however, we can now trace with some degree of accuracy. In mechanical operations, we can often follow this process still more completely. When motion is communicated from any body to another, it is distributed through all the parts of that other, by a law quite beyond the reach of sense to perceive directly, but yet subject to investigation, and determined by a principle which, though late in being discovered, is now generally recognised. The applications of this mechanical principle are perhaps the instances in which a latent, and, indeed, a very recondite process, has been most completely analysed.'

[38] Sc. the ultimate particles of bodies.

sunt minora quam ut sensum feriant, nemo se naturam regere aut vertere posse speret, nisi illa debito modo comprehenderit et notaverit.

VII.

Similiter, inquisitio et inventio *latentis schematismi*[39] in corporibus res nova est, non minus quam inventio *latentis processus* et formae[40]. Versamur enim plane adhuc in atriis naturae, neque ad interiora paramus aditum. At nemo corpus datum nova natura dotare vel in novum corpus foeliciter et apposite transmutare potest, nisi corporis alterandi aut transformandi bonam habuerit notitiam. In modos enim vanos incurret, aut saltem difficiles et perversos, nec pro corporis natura in quod operatur. Itaque ad hoc etiam via plane est aperienda et munienda.

Atque in anatomia corporum organicorum (qualia sunt hominis et animalium) opera sane recte et utiliter insumitur, et videtur res subtilis et scrutinium naturae bonum. At hoc genus anatomiae spectabile est, et sensui subjectum, et in corporibus tantum organicis locum habet. Verum hoc ipsum obvium quiddam est, et in promptu situm, prae anatomia vera *schematismi latentis* in corporibus quae habentur pro similari-

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[39] By the 'latent schematism' Bacon seems to mean the configuration and relative position of the ultimate particles of bodies. As Professor Playfair says, 'When we enquire into the constitution of crystals, or into the internal structure of plants, &c., we are examining into the latent schematism.'

[40] Notice that 'form' is here coupled with latent process, and distinguished from latent schematism. It must here, therefore, have the sense of law or cause rather than of essence.

'The distinction between the Latent Process and Latent Schematism in the absolute way in which it is here stated, involves an assumption which the progress of science will probably show to be unfounded; namely, that bodies apparently at rest are so molecularly. . . . . . The introduction of the idea of unstable equilibrium in connexion with organic chemistry, was a step in the direction which molecular Physics will probably soon take.'

The view propounded in the above note by Mr. Ellis as to the ultimate constitution of bodies is that which is now generally adopted. Bacon himself, however, says distinctly (Aph. 48, ad fin.): 'In corporibus hic apud nos nulla vera est quies, nec in integris, nec in partibus; sed tantum secundum apparentiam.'

bus [41]: praesertim in rebus specificatis [42] et earum partibus, ut ferri, lapidis; et partibus similaribus plantae, animalis, veluti radicis, folii, floris, carnis, sanguinis, ossis, etc. At etiam in hoc genere non prorsus cessavit industria humana; hoc ipsum enim innuit separatio corporum similarium per distillationes et alios solutionum modos, ut dissimilaritas compositi per congregationem partium homogenearum appareat. Quod etiam ex usu est, et facit ad id quod quaerimus; licet saepius res fallax sit; quia complures naturae separationi imputantur et attribuuntur, ac si prius substitissent in composito, quas revera ignis et calor et alii modi apertionum de novo indunt et superinducunt. Sed et haec quoque parva pars est operis, ad inveniendum *schematismum* verum in composito; qui *schematismus* res est longe subtilior et accuratior, et ab operibus ignis potius confunditur quam eruitur et elucescit.

Itaque facienda est corporum separatio et solutio; non per ignem certe, sed per rationem et *inductionem* veram, cum experimentis auxiliaribus; et per comparationem ad alia corpora, et reductionem ad naturas simplices et earum formas [43],

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[41] That is, which are homogeneous. It is comparatively easy to distinguish heterogeneous parts; but the anatomy which attempts to penetrate to the ultimate structure of homogeneous matter proposes to itself a task of transcendent difficulty.

[42] That is, in things which are distinguished as constituting separate species. The only reason, perhaps, that can be given why this should be the case, is that such things are usually of a more uniform structure than things which are not so distinguished.

The word 'stone' is, of course, used here in the most unscientific way. The same may be said of 'root,' 'leaf,' &c., below.

[43] Here 'forms' are spoken of in connection with 'latent schematisms,' though, at the beginning of the Aphorism, form was distinguished from latent schematism and coupled with latent process. This circumstance affords a good illustration of the vagueness and ambiguity of the term, and of the mode in which Bacon seems to oscillate between its two meanings.

The various 'Schematismi Materiae' are enumerated in the De Augmentis, lib. iii. cap. 4 (E. and S., vol. i. p. 560). In the passage in the text, Bacon seems to think that, in order to determine the latent schematism or ultimate constitution of any body, we must specify its qualities, dense, heavy, hot, &c., and then proceed to ascertain the 'forms' of these qualities. The knowledge of the 'forms' of these 'simple natures' will give all the information which we require. It is needless to point out how vague, undetermined, and purely relative are most of the terms which he employs to designate the simple natures, or how different is the roundabout

quae in composito conveniunt et complicantur; et transeundum plane a Vulcano ad Minervam, si in animo sit veras corporum texturas et *schematismos* (unde omnis occulta atque, ut vocant, specifica proprietas et virtus in rebus pendet; unde etiam omnis potentis alterationis et transformationis norma educitur) in lucem protrahere.

Exempli gratia; inquirendum, quid sit in omni corpore spiritus, quid essentiae tangibilis; atque ille ipse spiritus[44], utrum sit copiosus et turgeat, an jejunus et paucus; tenuis, aut crassior; magis aëreus, aut igneus; acris, aut deses; exilis, aut robustus; in progressu, aut in regressu; abscissus, aut continuatus; consentiens cum externis et ambientibus, aut dissentiens; etc. Et similiter, essentia tangibilis (quae non pauciores recipit differentias, quam spiritus) atque ejus villi, et fibrae, et omnimoda textura; rursus autem collocatio spiritus per corpoream molem, ejusque pori, meatus, venae, et cellulae, et rudimenta, sive tentamenta corporis organici, sub eandem inquisitionem cadunt. Sed et in his quoque, atque adeo in omni *latentis schematismi* inventione, lux vera et clara ab axiomatibus primariis[45] immittitur, quae certe caliginem omnem et subtilitatem discutit.

VIII.

Neque propterea res deducetur ad atomum, quae praesupponit vacuum[46] et materiam non fluxam[47] (quorum utrumque

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process which he here contemplates from that which recent investigators into the ultimate constitution of bodies have, with the help of the microscope, actually pursued.

[44] For Bacon's curious speculations on 'Spirit,' see Aph. 40, with notes, and also i. 50, with note 82. The 'spiritus' is distinguished from the 'essentia tangibilis' as being intangible and invisible. In Aph. 40, it is described as being included in all tangible bodies. 'Omne enim tangibile apud nos continet spiritum invisibilem et intactilem, eique obducitur, atque eum quasi vestit.'

[45] That is, the axioms which convey a knowledge of the 'forms' of 'simple natures.' Cp. Aph. 5: 'Primaria illa et catholica axiomata de naturis simplicibus;' 'Sed altiores et radicales operationes super naturam pendent utique ab axiomatibus primariis.'

[46] In Aph. 48 (conclusion), he speaks more doubtfully: 'Neque enim pro certo affirmaverimus, utrum detur vacuum, sive coacervatum, sive permistum.'

The Atomic theory of Democritus postulated a vacuum between the

falsum est), sed ad particulas veras, quales inveniuntur. Neque rursus est, quod exhorreat quispiam istam subtilitatem, ut inexplicabilem; sed contra, quo magis vergit inquisitio ad naturas simplices, eo magis omnia erunt sita in plano et perspicuo; translato negotio a multiplici in simplex, et ab incommensurabili ad commensurabile, et a surdo ad computabile, et ab infinito et vago ad definitum et certum; ut fit in elementis literarum, et tonis concentuum [47a]. Optime autem cedit inquisitio naturalis, quando physicum terminatur in mathematico [48].

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various atoms of which matter was regarded as composed. Λεύκιππος δὲ καὶ ὁ ἑταῖρος αὐτοῦ Δημόκριτος στοιχεῖα μὲν τὸ πλῆρες καὶ τὸ κενὸν εἶναί φασι. Arist. Metaph. i. 4 (985 b). Bacon, at least in this passage, while adopting the opinion that matter, in its ultimate analysis, is an aggregate of minute particles, repudiates the assumption that these particles are separated by a vacuum. His own view appears to have been that, if we could discover the inmost constitution of things, we should find the ultimate particles, not separated by a vacuum, but so nicely adjusted as to leave no breach of continuity in passing from one to another.

M. Bouillet gives an appropriate reference to the beginning of the treatise 'Cogitationes de Natura Rerum' (E. and S., vol. iii. pp. 15, &c.). Cp. also Nov. Org. i. 66, ad fin.

On the question whether Bacon did or did not reject the doctrine of a vacuum, see my notes on ii. 48 (2) and on the conclusion of the same Aphorism.

On the conception of ultimate particles of matter, cp. a very interesting passage in Newton's Optics, bk. iii. qu. 31 (Horsley's Ed., vol. iv. pp. 260–1).

[47] Mr. Kitchin thinks that this expression refers to the Democritean doctrine of the Eternity of Matter. May not Bacon mean Discontinuous Matter, which is implied, if we admit the theory of a vacuum?

[47a] 'Tones' are, as it were, the alphabet of Music. The above passage is important as throwing light on Bacon's doctrine of forms and simple natures. It shews, as I have pointed out elsewhere, that he regarded the 'simple natures' as constituting a sort of alphabet, and that he supposed that, if we only possessed a complete knowledge of this alphabet, we should be able to explain and reproduce nature in all her complexity.

[48] Cp. i. 96 and note 72. The meaning of the passage in the text, when taken in connection with the context, is somewhat doubtful. It may refer generally to the deductive branches of natural philosophy, stated and worked out mathematically (as I believe is the case with the passage in i. 96), or (as the context would rather lead us to suppose) it may have a more special reference. In the latter case, it probably contemplates the application of mathematics to the enumeration, mensuration, and determination of the form of the ultimate particles of matter; or possibly it may have reference to the combination of 'simple natures' in concrete substances, mathematics being applied to determine the number of such

At rursus multitudinem aut fractiones nemo reformidet [49]. In rebus enim, quae per numeros transiguntur, tam facile quis posuerit aut cogitaverit millenarium, quam unum; aut millesimam partem unius, quam unum integrum.

IX.

Ex duobus generibus axiomatum, quae superius posita sunt [50], oritur vera divisio philosophiae et scientiarum; translatis vocabulis receptis (quae ad indicationem rei proxime accedunt) ad sensum nostrum. Videlicet, ut inquisitio *formarum*, quae sunt (ratione certe, et sua lege [51]) aeternae et immobiles, constituat *metaphysicam* [52]; inquisitio vero *efficientis*, et *materiae*, et *latentis processus*, et *latentis schematismi* (quae omnia cursum naturae communem et ordinarium, non leges fundamentales et aeternas respiciunt [53]) constituat *physicam*: atque his subordinentur similiter practicae duae; *physicae mechanica*; *metaphysicae* (perpurgato nomine)

'simple natures' which are to be found in any given substance, or are requisite to its production, and, perhaps, also the several proportions in which they are combined.

[49] This sentence does not appear to mean more than that in Mathematics we may have to deal with very large or very small quantities. There may possibly be an allusion to a curious passage in the Republic of Plato (bk. vii. p. 525 E), where Socrates says that the arithmetician will not tolerate fractions, but insists on multiplying them back again into integers.

[50] See Aph. 5.

[51] 'Meaning,' says Mr. Ellis, 'that God could change them, but that this change would be above reason and a change of the law of the form, otherwise unchangeable.'

[52] Cp. De Augmentis, iii. 4. There he includes the investigation of Final Causes under Metaphysic. Here, as they stand in no relation to the present discussion, he omits all mention of them.

It is, perhaps, needless to observe that this is a special and arbitrary use of the word 'Metaphysic.' The word, as I have already pointed out (Bk. i. Aph. 63. n. 30), originated as a designation of the books constituting a certain treatise of Aristotle (τὰ μετὰ τὰ φυσικά), which was regarded by those who arranged Aristotle's works as a sort of appendix to the Physics. On the various and often contradictory meanings which it has subsequently borne, it would be beside my purpose to speak.

[53] In this Aphorism, it would be difficult to say whether 'forms' are used in the sense of 'laws' or 'essences.' Bacon probably had no clear perception of the distinction between the two ideas.

magia[54], propter latas ejus vias et majus imperium in naturam.

X.

Posito itaque doctrinae scopo, pergendum ad praecepta; idque ordine minime perverso aut perturbato. Atque indicia de *interpretatione naturae* complectuntur partes in genere duas[55]; primam, de educendis aut excitandis axiomatibus ab experientia; secundam, de deducendis aut derivandis experimentis novis ab axiomatibus. Prior autem trifariam dividitur: in tres nempe ministrationes; ministrationem ad sensum, ministrationem ad memoriam, et ministrationem ad mentem sive rationem[56].

Primo enim paranda est *historia naturalis* et *experimentalis*, sufficiens et bona; quod fundamentum rei est: neque enim fingendum, aut excogitandum, sed inveniendum, quid natura faciat aut ferat.

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[54] Cp. De Augmentis, iii. 5, which will furnish a full explanation of this passage.

[55] Namely, Induction and Deduction. On the latter method, the Novum Organum, in its fragmentary state, contains nothing (unless we except the Instances mentioned in ii. 52, as conducing 'ad operativam'), though the seventh, ninth, and possibly fourth parts (see Aph. 21) were to deal with this subject.

M. Bouillet remarks that, in the Partis Secundae Delineatio, the Pars Activa is distinguished from the Deductive branch of the Pars Contemplativa, whereas here the two are spoken of as one. See E. and S., vol. iii. pp. 556–7. M. Bouillet also remarks that it is doubtful whether Bacon would have found in the practical or operative part sufficient matter for a special treatise, bearing in mind what he himself says: 'inter contemplativam partem activam perpetuo intercurrere' (Partis Secundae Delineatio, E. and S., vol. iii. p. 556).

[56] This division, as given in the present passage, is easily explicable. The 'ministratio ad sensum' supplies a collection of observations and experiments, 'Historia Naturalis et Experimentalis.' The 'ministratio ad memoriam' arranges these in Tables, in a form adapted for use. The 'ministratio ad mentem sive rationem' is the process of Induction itself, drawing from the tables the inferences to which they legitimately lead. M. Bouillet has a long note on the mode in which the two first 'ministrationes' may be supplied from different parts of Bacon's works.

On the discrepancy between the account of these 'ministrationes' as given here and in the Partis Secundae Delineatio, the student, who is curious to trace the growth of Bacon's doctrine, may refer to Mr. Spedding's note on the present passage and to the General Preface, prefixed to the 1st vol. of Ellis and Spedding's Edition, § 10.

Historia vero *naturalis* et *experimentalis* tam varia est et sparsa, ut intellectum confundat et disgreget, nisi sistatur et compareat ordine idoneo. Itaque formandae sunt *tabulae* et *coordinationes instantiarum*, tali modo et instructione ut in eas agere possit intellectus.

Id quoque licet fiat, tamen intellectus sibi permissus, et sponte movens, incompetens est et inhabilis ad opificium axiomatum, nisi regatur et muniatur. Itaque tertio, adhibenda est *inductio* legitima et vera, quae ipsa *clavis* est *interpretationis*. Incipiendum autem est a fine, et retro pergendum ad reliqua [57].

XI.

Inquisitio formarum sic procedit; super naturam datam primo facienda est *comparentia* [58] *ad intellectum* omnium *instantiarum* notarum, quae in eadem natura conveniunt per materias licet dissimillimas. Atque hujusmodi collectio facienda est historice [59], absque contemplatione praefestina, aut subtilitate aliqua majore. Exempli gratia; in inquisitione de forma calidi [60].

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[57] It must be recollected that the 'Tables' which occur in the Novum Organum are only specimens of what Bacon designed. From the 'Distributio Operis,' we learn that the first 'ministratio' was to be treated in the third part of the Instauratio Magna, and the second 'ministratio' in the fourth part.

[58] An 'appearance,' a word borrowed from legal phraseology. We have the phrase 'to enter' or 'to put in' an appearance.

This investigation into the nature of Heat (Aphs. 11–20) was included in a small volume, published at Leyden in 1638, entitled 'Francisci de Verulamio Historia Naturalis et Experimentalis De Ventis,' &c. See Introduction, § 17.

[59] That is, according to the actual order in which they present themselves to the investigator in the course of his observations; not according to any predetermined order. The order of arrangement must be determined after collection, when all the instances are before us; otherwise, we are in danger of overlooking altogether instances which may be material to our enquiry.

[60] Rémusat (Bacon, &c., p. 246) translates 'forma calidi' by *nature* of heat. And this, perhaps, is the nearest equivalent (cp. the fourth paragraph of Aph. 20, beginning 'Intelligatur hoc,' &c.). But, as a knowledge of the *nature* of heat implies a knowledge of its *cause* and of the *law* of its production, we may, in this instance, employ all three words alike in illustration of Bacon's use of the word 'Form.'

Instantiae[61] *convenientes in natura calidi.*

1. Radii solis, praesertim aestate et meridie.
2. Radii solis reflexi et constipati, ut inter montes, aut per parietes, et maxime omnium in speculis comburentibus.

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[61] The significance of these Instances, as well as of the Tables which occur in the following Aphorisms, may, perhaps, best be understood by comparing them with the far more natural and scientific form which they assume in Mr. Mill's 'Experimental Methods.' To assist the student in this task, I extract the following passages from one of the notes in my Inductive Logic (ch. 3, Appended Note 2, 3rd Ed., pp. 207–9):

'If the "Instantiae convenientes in natura calidi" were so related to one another that, besides the given phenomenon (heat), only one other circumstance were common to them all, that other circumstance might be regarded, with more or less probability, as the cause (or effect) of heat, or, at least, as connected with it through some fact of causation. Such instances would then come under the Method of Agreement.

'If one instance in the Table of Agreement ("Instantiae convenientes in natura calidi") were so related to one of the instances in the Table of Privation ("Instantiae in proximo, quae privantur natura calidi") as to have every circumstance in common with it, except that the former, besides presenting the phenomenon of heat which is supposed to be absent in the latter, also presented some other circumstance which was absent from the latter, this other circumstance would be the cause, or a necessary part of the cause (or effect), of heat. We should here have the Method of Difference.

'If, in the "Tabula graduum, sive comparativae in calido" we could discover some one phenomenon which increased or diminished proportionately with the increase or diminution of heat, that phenomenon would be the cause or the effect of heat, or, at least, connected with it through some fact of causation, and would conform to the requirements of the Method of Concomitant Variations. If it could be shown that this phenomenon and heat were the *only* circumstances which varied concurrently, then the phenomenon would be proved to be either the cause or the effect of heat, and would conform to the requirements of the rider to this last Method' (given in Inductive Logic, p. 182).

'The "Exemplum exclusivae, sive rejectionis naturarum a forma calidi" bears some, though, it must be acknowledged, a very slight, resemblance to the Method of Residues. These "rejectiones" consist in excluding some possible explanation of the phenomenon, either because an instance, which does not present the phenomenon, does present the assigned cause, or because an instance, which does present the phenomenon, does not present the assigned cause. As an instance of the former, we may take the following "rejectio": "Per radios lunae (which were then supposed to be cold) et aliarum stellarum rejice lucem et lumen." As instances of the latter, we may take the two following: "Per radios solis, rejice naturam elementarem (that is, "terrestrial nature," which is composed of "the four

3. Meteora ignita.
4. Fulmina comburentia.
5. Eructationes flammarum ex cavis montium, etc.
6. Flamma omnis.
7. Ignita solida.
8. Balnea calida naturalia.
9. Liquida ferventia, aut calefacta.
10. Vapores et fumi ferventes, atque aër ipse, qui fortissimum et furentem suscipit calorem, si concludatur; ut in reverberatoriis [62].
11. Tempestates aliquae sudae [63] per ipsam constitutionem aëris, non habita ratione temporis anni.
12. Aër conclusus et subterraneus in cavernis nonnullis, praesertim hyeme.
13. Omnia villosa, ut lana, pelles animalium, et plumagines, habent nonnihil teporis.
14. Corpora omnia, tam solida, quam liquida, et tam densa, quam tenuia (qualis est ipse aër), igni ad tempus approximata.
15. Scintillae ex silice et chalybe per fortem percussionem.
16. Omne corpus fortiter attritum, ut lapis, lignum, pannus, etc.; adeo ut temones et axes rotarum aliquando flammam concipiant: et mos excitandi ignis apud Indos occidentales fuerit per attritionem.

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elements"); Per ignem communem, et maxime per ignes subterraneos (qui remotissimi sunt, et plurimum intercluduntur a radiis coelestibus) rejice naturam coelestem." By a succession of these "rejectiones," we limit the number of possible explanations, amongst which we are to look for the true one. Bacon's "rejections," however, not being, as a matter of fact, exhaustive, lead to a purely negative result; they may save us from unnecessary trouble in seeking for a cause where it cannot be found, but they do not, like the Method of Residues, leave a definite number of antecedents which either constitute the cause, or amongst which we know that the cause is to be sought.'

[62] 'Reverberatories are furnaces constructed with two chambers; an outer one, which has no chimney, but has a passage connecting it with an inner one which has a chimney. The substance to be exposed to the heat is placed on the floor of the inner chamber, and fire is lighted in the other: so that the flame, having no outlet in the outer chamber, passes into the inner, over the substance, and is so concentrated with vast power upon it.' Mr. Kitchin's note.

[63] Se-udae. Cloudless, clear.

17. Herbae virides et humidae simul conclusae et contrusae, ut rosae, pisae[64] in corbibus; adeo ut foenum, si repositum fuerit madidum, saepe concipiat flammam.
18. Calx viva, aqua aspersa.
19. Ferrum, cum primo dissolvitur per aquas fortes in vitro, idque absque ulla admotione ad ignem: et stannum similiter, etc. sed non adeo intense.
20. Animalia, praesertim et perpetuo per interiora; licet in insectis calor ob parvitatem corporis non deprehendatur ad tactum.
21. Fimus equinus, et hujusmodi excrementa animalium recentia.
22. Oleum forte sulphuris et vitrioli[65] exequitur opera caloris, in linteo adurendo.
23. Oleum origani, et hujusmodi, exequitur opera caloris in adurendis ossibus dentium.
24. Spiritus vini fortis et bene rectificatus exequitur opera caloris; adeo ut si albumen ovi in eum injiciatur, concrescat et albescat, fere in modum albuminis cocti; panis injectus torrefiat et incrustetur, ad modum panis tosti[66].
25. Aromata, et herbae calidae, ut dracunculus[67], nasturtium vetus, etc. licet ad manum non sint calida (nec integra, nec pulveres eorum), tamen ad linguam et palatum

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[64] Mr. Ellis reads *pinsae*, but the two words have the same meaning, namely, 'crushed' or 'pounded.'

[65] This is probably an instance of the grammatical figure, ἓν διὰ δυοῖν, meaning, as Mr. Kitchin suggests, Sulphuric Acid.

Of the substances alluded to in this and some of the following examples, Sir John Herschel (Discourse on the Study of Natural Philosophy, § 345) remarks that they 'excite in our organs, and especially in that of taste, a sensation of heat which they owe to their being chemical stimulants, and not at all to their being actually hot.'

[66] The latter phenomenon, Mr. Ellis remarks, 'arises probably from the desiccative power due to the strong affinity of alcohol for water.'

[67] 'Dragon-wort.' It was so called, because it was supposed to be obnoxious to serpents, and also to be efficacious against their bites. See Pliny, Nat. Hist. xxiv. sects. 142–150, chs. 91–93. In quoting or referring to Pliny's Natural History, I shall employ the Teubner edition of 1857, and refer both to the sections and to the chapters as numbered within brackets.

parum masticata percipiuntur calida, et quasi adurentia.

26. Acetum forte, et omnia acida, in membro ubi non sit epidermis, ut in oculo, lingua, aut aliqua alia parte vulnerata, et cute detecta, dolorem cient, non multum discrepantem ab eo, qui inducitur a calido.

27. Etiam frigora acria et intensa inducunt sensum quendam ustionis;

Nam Boreae penetrabile frigus adurit[68].

28. Alia.

Hanc *tabulam essentiae et praesentiae* appellare consuevimus.

XII.

Secundo, facienda est *comparentia* ad intellectum *instantiarum*, quae natura data privantur: quia forma (ut dictum est) non minus abesse debet, ubi natura data abest, quam adesse, ubi adest[69]. Hoc vero infinitum esset in omnibus.

Itaque subjungenda sunt *negativa affirmativis*, et privationes inspiciendae tantum in illis subjectis quae sunt maxime cognata illis alteris, in quibus natura data inest et comparet. Hanc *tabulam declinationis*, sive *absentiae in proximo*[70], appellare consuevimus.

Instantiae in proximo, quae privantur natura Calidi.

Ad Instantiam primam *affirmativam*, Instantia prima *negativa* vel subjunctiva.

1. Lunae et stellarum et cometarum radii non inveniuntur calidi ad tactum[71]: quinetiam observari solent acerrima frigora in pleniluniis[72]. At

[68] Virg. Georg. i. 93.

[69] So far as Form = Cause, it must, as already remarked, be absent where the given nature is absent (unless counteracting causes have destroyed its effects), but (owing to the circumstance of Plurality of Causes) it need not necessarily be present, where the given nature is present; for the given nature may also be due to some other cause.

[70] The value of these instances depends, of course, on the extent of their approximation to the Instantiae Convenientes, or, in other words, on the extent to which the two instances, when taken together, fulfil the conditions of the Method of Difference. The more closely they approach in other respects, the more likely are we to detect the cause of their variation.

[71] On the very interesting experiment by which Melloni, in spite of

stellae fixae majores, quando sol eas subit aut iis approximatur, existimantur fervores solis augere et intendere; ut fit cum sol sistitur in Leone, et diebus canicularibus[73].

Ad 2am 2a. 2. Radii solis in media (quam vocant) regione aëris non calefaciunt; cujus ratio vulgo non male redditur; quia regio illa nec satis appropinquat ad corpus solis, unde radii emanant, nec etiam ad terram, unde reflectuntur[74]. Atque hoc liquet ex fastigiis montium (nisi sint praealti), ubi nives perpetuo durant. Sed contra notatum est a nonnullis, quod in cacumine Picus de Tenariph, atque etiam in Andis Peruviae, ipsa fastigia montium nive destituta sint; nivibus jacentibus tantum inferius in ascensu[75]. Atque insuper aër illis ipsis verticibus montium deprehenditur minime frigidus, sed tenuis tantum et acer; adeo ut in Andis pungat et vulneret oculos per nimiam acrimoniam, atque etiam pungat os ventriculi, et inducat vomitum. Atque ab antiquis notatum est, in vertice Olympi tantam fuisse aëris tenuitatem, ut necesse fuerit illis qui eo ascenderant secum deferre spongias aceto et aqua madefactas, easque ad os et nares subinde apponere, quia aër ob tenuitatem non sufficiebat

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great difficulties, detected heat in the lunar rays, see Tyndall's Heat considered as a Mode of Motion, § 566.

[72] On the night of full-moon, though not before or after, a series of observations shews that the sky is, on an average, clearer than at other times. (See Herschel's Familiar Lectures on Scientific Subjects, pp. 146–7.) As a consequence of the diminution of the cloudy envelope, the night will also be colder.

[73] This influence of the fixed stars is, of course, purely imaginary, and the remark, moreover, shews that Bacon entertained the crudest views of astronomical distances.

I may here state that I shall not, as a rule, attempt, in the notes on the remainder of this Book, to comment on Bacon's scientific examples, or to note his scientific errors, unless they present some feature of special interest. The object of this edition is to illustrate the logical and philosophical, rather than the scientific position of the author, and hence the latter, though I shall by no means ignore it, will usually be regarded as subordinate to the former.

[74] The true reason is the increasing rarefaction of the atmosphere, as we ascend from the sea-level.

[75] Simply because the peaks are so steep that the snow will not rest on them.

respirationi[76]: in quo vertice etiam relatum est, tantam fuisse serenitatem et tranquillitatem a pluviis et nivibus et ventis[77], ut sacrificantibus literae descriptae digito in cineribus sacrificiorum super aram Jovis, manerent in annum proximum absque ulla perturbatione[78]. Atque etiam hodie ascendentes ad verticem Picus de Tenariph eo vadunt noctu et non interdiu; et paulo post ortum solis monentur et excitantur a ducibus suis ut festinent descendere, propter periculum (ut videtur) a tenuitate aëris, ne solvat spiritus et suffocet.

Ad 2am 3a. Reflexio radiorum solis, in regionibus prope circulos polares, admodum debilis et inefficax invenitur in calore: adeo ut Belgae, qui hybernarunt in Nova Zembla[79], cum expectarent navis suae liberationem et deobstructionem a glaciali mole (quae eam obsederat) per initia mensis Julii spe sua frustrati sint, et coacti scaphae se committere. Itaque radii solis directi videntur parum posse, etiam super terram planam; nec reflexi etiam, nisi multiplicentur et uniantur,

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[76] I have not been able to trace this allusion to any classical writer. The story, however, occurs in Augustine, De Genesi contra Manichaeos, lib. i. cap. 15. Bacon notes it also in the Fragment entitled 'Calor et Frigus' (E. and S., vol. iii. p. 645).

[77] Ἡ μὲν ἄρ' ὣς εἰποῦσ' ἀνέβη γλαυκῶπις Ἀθήνη
Οὔλυμπόνδ', ὅθι φασὶ θεῶν ἕδος ἀσφαλὲς αἰεὶ
ἔμμεναι· οὔτ' ἀνέμοισι τινάσσεται οὔτε ποτ' ὄμβρῳ
δεύεται οὔτε χιὼν ἐπιπίλναται, ἀλλὰ μάλ' αἴθρη
πέπταται ἀνέφελος, λευκὴ δ' ἐπιδέδρομεν αἴγλη·
τῷ ἔνι τέρπονται μάκαρες θεοὶ ἤματα πάντα.

Homer, Od. vi. 41–6.

The student will do well to read Mr. Merry's instructive note on these lines. He quotes several parallel passages.

[78] See the Aristotelian or pseudo-Aristotelian Problemata, xxvi. 36 (p. 944 b. 12–16), where, however, the author specifies Athos and 'other such mountains.' Pomponius Mela (lib. ii. cap. 2) refers also to Athos. Solinus describes the phenomenon as taking place both on Olympus (Polyhistor, cap. ix) and on Athos (cap. xi). Mr. Ellis cites Geminus and Philoponus, the former of whom speaks of Mount Cyllene in Arcadia, and the latter of Olympus. Augustine tells the story, at least twice, of Olympus.

All these stories are told of both Olympus and Athos in Maundeville's Travels (Ed. Halliwell, p. 17), quoted by Mr. Tozer in his Highlands of Turkey, vol. i. p. 102.

[79] Referring to Barentz's Expedition in search of a North-East Passage. The event alluded to took place in June, 1597. Mr. Spedding refers to 'Three Voyages by the North-East,' &c., Hackluyt Society, 1853, p. 191.

quod fit cum sol magis vergit ad perpendiculum, quia tum incidentia radiorum facit angulos acutiores, ut lineae radiorum sint magis in propinquo: ubi contra in magnis obliquitatibus solis anguli sint valde obtusi, et proinde lineae radiorum magis distantes. Sed interim notandum est, multas esse posse operationes radiorum solis, atque etiam ex natura calidi, quae non sunt proportionatae ad tactum nostrum: adeo ut respectu nostri non operentur usque ad calefactionem, sed respectu aliorum nonnullorum corporum exequantur opera calidi.

Ad 2am 4a. Fiat hujusmodi experimentum. Accipiatur speculum[80] fabricatum contra ac fit in speculis comburentibus, et interponatur inter manum et radios solis; et fiat observatio, utrum minuat calorem solis, quemadmodum speculum comburens eundem auget et intendit. Manifestum est enim, quoad radios opticos, prout fabricatur speculum in densitate inaequali respectu medii et laterum, ita apparere simulachra magis diffusa aut magis contracta. Itaque idem videndum in calore.

Ad 2am 5a. Fiat experimentum diligenter, utrum per specula comburentia fortissima et optime fabricata radii lunae possint excipi et colligi in aliquem vel minimum gradum teporis[81]. Is vero gradus teporis si fortasse nimis subtilis et debilis fuerit, ut ad tactum percipi et deprehendi non possit, confugiendum erit ad vitra illa[82] quae indicant constitutionem aëris calidam aut frigidam; ita ut radii lunae per speculum comburens

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[80] Used here for a lens.

[81] For a long time, the experiments which were applied to detect heat in the lunar rays were unsuccessful. For the successful experiment of Melloni, see Tyndall, as referred to above, note 71.

[82] The invention of the Thermometer, which was originally an Air Thermometer, is, according to different accounts, ascribed to Galileo in 1597, Drebbel of Alkmaer in 1609, Paolo Sarpi in 1609, and Sanctorio in 1610. M. Bouillet (note on Nov. Org. ii. 13 (38)) and M. de Vanzelles (Histoire, &c. de Bacon, vol. i. pp. 30–31) ascribe it, though on insufficient grounds, to Bacon himself. The merit of the invention probably belongs, in the first instance, to Galileo. See the authorities referred to in Mr. Ellis' note on ii. 13 (38), and especially the arguments employed by Libri, Histoire des Sciences Mathématiques en Italie, tome iv. pp. 187–197.

In Aphs. 13 and 24, Bacon calls this instrument Vitrum Calendare.

incidant et jaciantur in summitatem vitri hujusmodi; atque tum notetur, si fiat depressio aquae per teporem.

Ad 2am 6a. Practicetur etiam vitrum comburens super calidum, quod non sit radiosum aut luminosum; ut ferri et lapidis calefacti sed non igniti, aut aquae ferventis, aut similium; et notetur utrum fiat augmentum et intentio calidi, ut in radiis solis[83].

Ad 2am 7a. Practicetur etiam speculum comburens in flamma communi.

Ad 3am 8a. Cometarum (si et illos numerare inter meteora[84]

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[83] Mr. Kitchin has the following interesting note on this passage: 'The questions started here and in the next paragraph have been settled; and the result is such as proves the similarity in kind of Solar and other Heat; so that in these places no *Negative* can be adduced. Large lenses brought before lighted candles or the fire produce sensible Heat; and by collecting the rays of Heat in the atmosphere, even when the Sun is quite hidden behind clouds, concave Mirrors produce a definite increase of Heat at their focus. Farther than this, MM. Saussure and Pictet of Geneva have established the truth as to "ferrum, vel lapis calefactus, sed non ignitus," &c. by heating an iron ball so as not to be luminous, and by experimenting on boiling water. From the results they have shewn that Heat emanates in invisible rays, and is subject to the same laws of reflection, &c. as if it were accompanied by rays of light as well. Melloir has also established the fact that Heat is refrangible; and (like Light of different colours) Heat from different sources has different degrees of refrangibility. Forbes has established the polarisation of Heat from both luminous and non-luminous sources: he also depolarised Heat; and as this is a consequence solely of double refraction, he thereby has proved that Heat is subject also to the Laws of double refraction. See Turner's Chemistry, Heat, pp. 14–20.'

'Mersenne says the greater number of the experiments mentioned in the second book of the Novum Organum had already been made, and mentions particularly, as if he had himself tried it, the reflexion of all kinds of heat by a burning mirror. He also asserts that light is always accompanied by heat. De la Vérité des Sciences (1625), p. 210.' Mr. Ellis' note. In the great majority of cases, I think, there is nothing in Bacon's language to imply that the experiments suggested are original. See Aph. 14.

[84] It was a common subject of debate amongst the ancient astronomers whether Comets were to be regarded as Meteors (which were supposed to be engendered in the atmosphere), or whether they were more analogous to the Planets. The point is discussed in a most interesting manner in the Seventh Book of Seneca's Natural Questions. 'Placet ergo nostris cometas sicut faces, sicut tubas trabesque et alia ostenta coeli denso aere creari.' He then argues with great ability against this view, referring to the comets

libuerit) non deprehenditur constans aut manifestus effectus in augendis ardoribus anni, licet siccitates saepius inde sequi notatae sint[85]. Quinetiam trabes et columnae lucidae et chasmata[86] et similia apparent saepius temporibus hybernis quam aestivis[87]; et maxime per intensissima frigora, sed conjuncta cum siccitatibus. Fulmina tamen et coruscationes et tonitrua raro eveniunt hyeme, sed sub tempus magnorum fervorum[88]. At stellae (quas vocant) cadentes existimantur

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which appeared in the time of Claudius and Nero, and sums up his own opinion as follows: 'Ego nostris non adsentior: non enim existimo cometen subitaneum ignem, sed inter aeterna opera naturae.' (Chaps. 21, 22.) A view somewhat similar to the former was regarded as possible even by Galileo. See Il Saggiatore, 20°, &c., where he defends, as a possible explanation of comets, the theory that they are formed by exhalations from the earth, rising to a great height and reflecting the light of the Sun. The return of Halley's Comet, nearly at the time predicted by him, in 1759, conclusively proved that these bodies belong to the solar, and not to the terrestrial system, and that, in the words of Seneca, they are 'aeterna opera naturae.'

[85] Neither the one effect nor the other, so far as I am aware, has ever been established by meteorological observation. At the same time, it would be rash to deny that comets might have either or both of these effects, especially if it be true, as the most recent spectrum analysis seems to shew, that 'the nucleus is self-luminous, and that it is very possibly composed of glowing gas containing carbon.' See a most interesting section on Comets and their Spectra in Dr. Schellen's Spectrum Analysis, translated by J. and C. Lassell, and edited by Dr. Huggins (Longmans, 1872).

[86] For 'trabes,' see Seneca's Natural Questions, i. 1, vii. 4, 5; for 'columnae flagrantes,' vii. 20; and for 'chasmata,' i. 14. As Mr. Kitchin observes, they are all of them clearly names for different appearances of the Aurora Borealis, unless we suppose that 'columnae clipeique flagrantes' may stand for the Zodiacal Light.

[87] This is not quite accurate. The annual maxima of these appearances are, taking an average, in March and October, the latter being the greater; and the annual minima in June and January. Whether the Aurora be an electrical phenomenon (as most meteorologists suppose), or whether (as some suppose) it be a cloud of meteoric dust ignited by friction with the atmosphere, there is nothing to connect it with the rate of temperature.

It is, of course, only on clear nights that the phenomenon can be seen, and such nights are generally cold.

[88] This is generally, though not universally, true. As aerial electricity is, in all probability, mainly due to evaporation, and this takes place to a much greater extent in hot weather than in cold, there is a good reason why thunder-storms should be more frequent in summer than in winter.

vulgo magis constare ex viscosa aliqua materia splendida et accensa[89], quam esse naturae igneae fortioris. Sed de hoc inquiratur ulterius.

Ad 4^{am} 9^{a}. Sunt quaedam coruscationes[90] quae praebent lumen sed non urunt; eae vero semper fiunt sine tonitru.

Ad 5^{am} 10^{a}. Eructationes et eruptiones flammarum inveniuntur non minus in regionibus frigidis quam calidis; ut in Islandia et Groenlandia: quemadmodum et arbores per regiones frigidas magis sunt quandoque inflammabiles et magis piceae ac resinosae quam per regiones calidas; ut fit in abiete, pinu, et reliquis: verum in quali situ et natura soli hujusmodi eruptiones fieri soleant, ut possimus *affirmativae* subjungere *negativam*, non satis quaesitum est[91].

Ad 6^{am} 11^{a}. Omnis flamma perpetuo est calida magis aut minus[92], neque omnino subjungitur *negativa:* et tamen referunt ignem fatuum[93] (quem vocant), qui etiam aliquando impingitur in parietem, non multum habere caloris; fortasse instar flammae spiritus vini, quae clemens et lenis est[94]. Sed

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[89] This opinion probably arose from their pear-like shape as they dart across the heavens, and from the manner in which they appear to be suddenly kindled and then again suddenly extinguished. In reality, these aerolites usually consist mainly of metallic iron, the rest of their substance being made up of a variety of other metals.

[90] Sheet-lightning. This phenomenon occurs when the discharge of electricity takes place below the horizon, or behind a dense cloud, or at great elevations above the earth's surface. On these occasions, the distance is too great or the intervening obstacle too dense for the thunder to be heard.

[91] We must recollect that, at this time, not even the conception of a science of geology had been formed. It is needless to say that volcanoes, hot springs (see below), and similar phenomena have no connection whatever with the temperature of the surface of the soil.

[92] The temperature of a flame depends on the nature of the substance burnt and on the nature of the medium in which the combustion takes place. For the relation between the heat and luminosity of different kinds of flame, see the article on Combustion in Watts' Dictionary of Chemistry.

[93] 'Will o' the Wisp.' This phenomenon probably arises from the escape of marsh gas (light carburetted hydrogen) from the earth at night-time, when a faint light is easily visible. How the gas becomes ignited, it is sometimes difficult to say. A frequent cause of its ignition, probably, is contact with phosphoretted hydrogen.

[94] As Mr. Kitchin says, 'the flame of spirits of wine, instead of being

adhuc lenior videtur ea flamma quae in nonnullis historiis fidis et gravibus invenitur apparuisse circa capita et comas puerorum et virginum[95]; quae nullo modo comas adurebat, sed molliter circum eas trepidabat. Atque certissimum est, circa equum[96] in itinere sudantem noctu et suda tempestate apparuisse quandoque coruscationem quandam absque manifesto calore. Atque paucis abhinc annis, notissimum est et pro miraculo quasi habitum gremiale cujusdam puellae paulo motum aut fricatum coruscasse; quod fortasse factum est ob alumen aut sales quibus gremiale tinctum erat paulo crassius haerentia et incrustata, et ex fricatione fracta[97]. Atque certissimum est saccharum omne, sive conditum (ut vocant) sive simplex, modo sit durius, in tenebris fractum aut cultello scalptum coruscare[98]. Similiter aqua marina et salsa noctu interdum invenitur, remis fortiter percussa, coruscare[99]. Atque

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"clemens et lenis," is one of the most intensely hot kinds of flame.' Bacon was probably deceived by the appearance.

[95] See the story about Servius Tullius in Livy, i. 39, and about Ascanius in Virg. Aen. ii. 679–86:

> 'Talia vociferans gemitu tectum omne replebat,
> Cum subitum dictuque oritur mirabile monstrum.
> Namque manus inter maestorumque ora parentum
> Ecce levis summo de vertice visus Iuli
> Fundere lumen apex, tactuque innoxia mollis
> Lambere flamma comas et circum tempora pasci.
> Nos pavidi trepidare metu, crinemque flagrantem
> Excutere et sanctos restinguere fontibus ignis.'

Similar stories are told of some of the Saints, as, for instance, St. Catherine of Alexandria and St. Bridget.

[96] Cp. note on St. Elmo's fire, below.

[97] 'The girl's apron was probably made of silk, and the "coruscatio" electric.' Mr. Kitchin's note.

[98] The crystals of sugar exhibit phosphorescence, when cut or rubbed.

[99] This beautiful phenomenon must be familiar to almost every one. The following extracts (I must apologise for their length) are taken from Mr. Darwin's Naturalist's Voyage Round the World, ch. 8:

'While sailing a little south of the Plata on one very dark night, the sea presented a wonderful and most beautiful spectacle. There was a fresh breeze, and every part of the surface, which during the day is seen as foam, now glowed with a pale light. The vessel drove before her bows two billows of liquid phosphorus, and in her wake she was followed by a milky train. As far as the eye reached, the crest of every wave was

etiam in tempestatibus spuma maris fortiter agitata noctu coruscat; quam coruscationem Hispani *pulmonem marinum* vocant[1]. De illa flamma autem quam antiqui nautae vocabant *Castorem et Pollucem*, et moderni *Focum Sancti Ermi*[2], qualem calorem habeat non satis quaesitum est.

Ad 7am 12a. Omne ignitum ita ut vertatur in ruborem igneum

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bright, and the sky above the horizon, from the reflected glare of these livid flames, was not so utterly obscure as over the vault of the heavens.

'As we proceed further southward the sea is seldom phosphorescent; and off Cape Horn I do not recollect more than once having seen it so, and then it was far from being brilliant. This circumstance probably has a close connexion with the scarcity of organic beings in that part of the ocean. After the elaborate paper by Ehrenberg, on the phosphorescence of the sea, it is almost superfluous on my part to make any observations on the subject. I may however add, that the same torn and irregular particles of gelatinous matter, described by Ehrenberg, seem in the southern as well as in the northern hemisphere, to be the common cause of this phenomenon. * * *

'Observing that the water charged with gelatinous particles is in an impure state, and that the luminous appearance in all common cases is produced by the agitation of the fluid in contact with the atmosphere, I am inclined to consider that the phosphorescence is the result of the decomposition of the organic particles, by which process (one is tempted almost to call it a kind of respiration) the ocean becomes purified.'

Whether this conjecture be true or not, there can be no doubt that the phosphorescence of the sea is often due to living organisms.

[1] Mr. Ellis remarks that this is 'merely a translation of *πνεύμων θαλάσσιος*, which is used by Dioscorides, *De Materia Medica*, ii. 39. The luminous appearance arises apparently from serpent medusae, which in texture are like the substance of the lungs, from which circumstance they derive the name which Dioscorides gives them.'

[2] 'St. Elmo's fire.' Cp. Historia Ventorum, Prognostica Ventorum, No. 43 (E. and S., vol. ii. pp. 69, 70), and Pliny's Natural History, bk. ii. 101 (ch. 37).

'The fire of St. Elmo, or Castor and Pollux, is a brilliant light which frequently appears on the summits of ships' masts, on the points of bayonets, on the tops of spears, and on the tips of the ears of horses (cp. passage above). It is obviously nothing more than the electricity discharging itself either from or into pointed bodies.' Article on Electricity in Encyclopaedia Britannica by Sir David Brewster. The writer then proceeds to add some interesting accounts of this phenomenon, as given by Lord Napier and the Comte de Forbin. The latter says, 'we saw from different points of the ship about thirty St. Elmo's fires.'

Mr. Ellis, following Humboldt, quotes Camoens:

'Vi claramente visto o lume vivo,
Que a maritima gente tem por santo
Em tempo de tormenta,' &c.

Os Lusiadas de Camoēs, canto v. est. 18.

etiam sine flamma perpetuo calidum est, neque huic *affirmativae* subjungitur *negativa;* sed quod in proximo est videtur esse lignum putre, quod splendet noctu neque tamen deprehenditur calidum; et squamae piscium putrescentes, quae etiam splendent noctu, nec inveniuntur ad tactum calidae; neque etiam corpus cicindelae aut muscae (quam vocant luciolam[3]) calidum ad tactum deprehenditur.

Ad 8am 13a. De balneis calidis, in quo situ et natura soli emanare soleant, non satis quaesitum est; itaque non subjungitur *negativa.*

Ad 9am 14a. Liquidis ferventibus subjungitur *negativa* ipsius liquidi in natura sua. Nullum enim invenitur liquidum tangibile quod sit in natura sua et maneat constanter calidum, sed superinducitur ad tempus tantum calor, ut natura ascititia: adeo ut quae potestate et operatione sunt maxime calida, ut spiritus vini, olea aromatum chymica, etiam olea vitrioli et sulphuris[4], et similia, quae paulo post adurunt, ad primum tactum sint frigida. Aqua autem balneorum naturalium excepta in vas aliquod et separata a fontibus suis defervescit perinde ac aqua igne calefacta. At verum est corpora oleosa ad tactum paulo minus esse frigida quam aquea; ut oleum minus quam aqua, sericum minus quam linteum. Verum hoc pertinet ad *Tabulam Graduum de Frigido.*

Ad 10am 15a. Similiter vapori fervido subjungitur *negativa* naturae ipsius vaporis, qualis apud nos invenitur. Etenim exhalationes ex oleosis, licet facile inflammabiles, tamen non inveniuntur calidae, nisi a corpore calido recenter exhalaverint.

Ad 10am 16a. Similiter aëri ipsi ferventi subjungitur *negativa* naturae aëris ipsius. Neque enim invenitur apud nos aër calidus; nisi fuerit aut conclusus, aut attritus[5], aut manifeste calefactus a sole, igne, aut aliquo alio corpore calido.

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[3] Luciola = the fire-fly, cicindela = the glow-worm. All the instances given in this section are phenomena of phosphorescence.

[4] Sulphuric Acid. See note 65 above. We may here again notice the same confusion as before between the temperature of an object itself and the manner in which it affects our senses.

[5] 'Subjected to friction.' The word cannot mean agitated or put in motion; for the passage would then contradict what is said in Inst. 22.

Ad 11am 17a. Subjungitur *negativa* tempestatum frigidarum magis quam pro ratione temporis anni, quae eveniunt apud nos flante Euro et Borea; quemadmodum et contrariae tempestates eveniunt flante Austro et Zephyro. Etiam inclinatio ad pluviam (praesertim temporibus hyemalibus) comitatur tempestatem tepidam; at gelu contra frigidam.

Ad 12am 18a. Subjungitur *negativa* aëris conclusi in cavernis tempore aestivo[6]. At de aëre concluso omnino diligentius inquirendum. Primo enim non absque causa in dubitationem venit, qualis sit natura aëris quatenus ad calidum et frigidum in natura sua propria. Recipit enim aer calidum manifesto ex impressione coelestium; frigidum autem fortasse ab expiratione terrae; et rursus in media (quam vocant) regione aeris a vaporibus frigidis et nivibus: ut nullum judicium fieri possit de aëris natura per aërem qui foras est et sub dio, sed verius foret judicium per aërem conclusum. Atqui opus est etiam ut aër concludatur in tali vasi et materia quae nec ipsa imbuat aërem calido vel frigido ex vi propria, nec facile admittat vim aëris extranei. Fiat itaque experimentum per ollam figularem multiplici corio obductam ad muniendam ipsam ab aëre extraneo, facta mora per tres aut quatuor dies in vase bene occluso; deprehensio autem fit post apertionem vasis vel per manum vel per vitrum graduum[7] ordine applicatum.

Ad 13am 19a. Subest similiter dubitatio[8], utrum tepor in lana

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[6] Both this and the phenomena noticed in Inst. 11 of Aph. 11 are really due to the same cause. Air is a bad conductor of heat, and hence, as Mr. Kitchin says, 'it receives it slowly and retains it long.' The air within a cavern being approximately of the same temperature in winter and summer, seems, as compared with the outer air, hot at the one season and cold at the other. It is for the same reason that, in walking up a high mountain, we may suffer intensely from the sun's rays over-head, while, if we retire into the shade, we may be almost frozen.

The following remarks show how little Bacon knew of the conduction of heat, or of the purely relative character of the expressions 'hot' and 'cold.' He thought that cold was as much a positive quality as heat.

[7] This word shows that the thermometer was already graduated in Bacon's time.

[8] The 'dubitatio' of Bacon has, of course, been wholly removed. The so-called 'warmth' of wool, skins, feathers, &c. is due to none of the causes which he suggests, but simply to the fact that they are bad conductors of heat, and hence, when the skin is covered with them, the animal warmth is retained.

et pellibus et plumis et hujusmodi fiat ex quodam exili calore inhaerente, quatenus excernuntur ab animalibus; aut etiam ob pinguedinem quandam et oleositatem, quae sit naturae congruae cum tepore; vel plane ob conclusionem et fractionem aëris, ut in articulo praecedente dictum est. Videtur enim omnis aër abscissus a continuitate aëris forinseci habere nonnihil teporis. Itaque fiat experimentum in fibrosis quae fiunt ex lino; non ex lana aut plumis aut serico, quae excernuntur ab animatis. Notandum est etiam, omnes pulveres (ubi manifesto includitur aër) minus esse frigidos quam corpora integra ipsorum[9]; quemadmodum etiam existimamus omnem spumam (utpote quae aërem contineat) minus esse frigidam quam liquorem ipsum.

Ad 14am 20a. Huic non subjungitur *negativa.* Nihil enim reperitur apud nos sive tangibile sive spiritale[10], quod admotum igni non excipiat calorem. In eo tamen differunt, quod alia excipiant calorem citius, ut aër[11], oleum, et aqua; alia tardius, ut lapis et metalla. Verum hoc pertinet ad *Tabulam Graduum.*

Ad 15am 21a. Huic Instantiae non subjungitur *negativa* alia, quam ut bene notetur non excitari scintillas ex silice et chalybe aut alia aliqua substantia dura nisi ubi excutiuntur minutiae aliquae ex ipsa substantia lapidis vel metalli, neque aërem attritum unquam per se generare scintillas[12], ut vulgo putant; quin et ipsae illae scintillae ex pondere corporis

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[9] This circumstance is, of course, due to the bad conducting power of air. See note 6 above.

[10] The word is evidently used in this place, not as opposed to material or corporeal, but as applying to aeriform fluids.

[11] There is a confusion here between the radiation of heat through the air and the conductivity of air itself. If we kindle a fire in a room, we at once feel the increased warmth through radiation; but if we extinguish it shortly afterwards, it will be found that the temperature of the air has hardly been perceptibly increased. The glass fire-screen is a familiar illustration of the same principle. Metals, on the other hand, are rapid conductors, as we may test by their coldness to the touch in ordinary temperatures.

[12] See Tyndall, Heat a Mode of Motion, § 25: 'When the air is compressed, heat is suddenly generated. Tinder may be ignited by this heat.' Compressed air, when expanded, on the other hand, has a chilling effect.

igniti magis vergunt deorsum quam sursum, et in extinctione redeunt in quandam fuliginem corpoream.

Ad 16am 22a. Existimamus huic instantiae non subjungi *negativam.* Nullum enim invenitur apud nos corpus tangibile, quod non ex attritione manifesto calescat[13]; adeo ut veteres somniarent non inesse coelestibus aliam viam aut virtutem calefaciendi nisi ex attritione aëris per rotationem rapidam et incitatam[14]. Verum in hoc genere ulterius inquirendum est, utrum corpora quae emittuntur ex machinis (qualia sunt pilae ex tormentis) non ex ipsa percussione contrahant aliquem gradum caloris; adeo ut postquam deciderint inveniantur nonnihil calida[15]. At aër motus magis infrigidat quam calefacit; ut in ventis et follibus et flatu oris contracti[16].

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[13] This is perfectly true. Motion or mechanical force and heat are mutually convertible. Motion may always be converted into heat, and heat into motion. This is the fundamental axiom of the modern science of Heat.

[14] Mr. Ellis refers to Arist. Meteorol. bk. i. ch. 2 (ch. 3 of Berlin Edition, p. 341 a) sub finem, and De Coelo, ii. 7 (p. 288 a). The latter passage is peculiarly interesting: ἡ δὲ θερμότης ἀπ' αὐτῶν (sc. τῶν ἄστρων) καὶ τὸ φῶς γίνεται παρεκτριβομένου τοῦ ἀέρος ὑπὸ τῆς ἐκείνων φορᾶς. πέφυκε γὰρ ἡ κίνησις ἐκπυροῦν καὶ ξύλα καὶ λίθους καὶ σίδηρον· εὐλογώτερον οὖν τὸ ἐγγύτερον τοῦ πυρός, ἐγγύτερον δὲ ὁ ἀήρ, οἷον καὶ ἐπὶ τῶν φερομένων βελῶν· ταῦτα γὰρ αὐτὰ ἐκπυροῦται οὕτως, κ.τ.λ. Mr. Ellis remarks that 'it seems probable that Aristotle was influenced by a wish to secure the doctrine of the eternity of the universe, which he saw would be put in peril if celestial heat was ascribed to anything akin to combustion.'

That Aristotle's theory was not inherently impossible will be plain from the following passage, taken from Tyndall's Heat a Mode of Motion, § 12: 'The most probable theory of shooting stars is that they are small planetary bodies revolving round the sun, which are caused to swerve from their orbits by the attraction of the earth, and are raised to incandescence by friction against our atmosphere. Chladni propounded this view, and Dr. Joule has shewn that the atmospheric friction is competent to produce the effect.' Professor Tyndall, at the beginning of this section, refers to Aristotle's statement that arrows are heated by passing through the air.

[15] This is so. A bullet or a cannon-ball is heated by passing through the air. Cp. what Aristotle says in the passage quoted above about the heating of arrows.

[16] The cooling effect in these cases is due to the fact that fresh draughts of air are constantly brought into contact with the body, the loss of heat from the latter being thus rendered more rapid than it would be if the

Verum hujusmodi motus non est tam rapidus ut excitet calorem, et fit secundum totum, non per particulas[17]; ut mirum non sit, si non generet calorem.

Ad 17am 23a. Circa hanc instantiam facienda est inquisitio diligentior. Videntur enim herbae et vegetabilia viridia et humida aliquid habere in se occulti caloris. Ille vero calor tam tenuis est ut in singulis non percipiatur ad tactum: verum postquam illa adunata sint et conclusa, ut spiritus ipsorum non expiret in aërem sed se invicem foveat, tum vero oritur calor manifestus, et nonnunquam flamma in materia congrua[18].

Ad 18am 24a. Etiam circa hanc instantiam diligentior facienda est inquisitio. Videtur enim calx viva aqua aspersa concipere calorem vel propter unionem caloris qui antea distrahebatur (ut ante dictum est de herbis conclusis), vel ob irritationem et exasperationem spiritus ignei ab aqua, ut fiat quidam conflictus et antiperistasis[19]. Utra vero res sit in causa facilius

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surrounding atmosphere were more nearly of the same temperature with itself.

17 Mr. Kitchin says: 'By this, I suppose, Bacon means, it affects the whole body generally, and does not cause friction of its separate particles. This view is of course wrong.'

18 This is a well-known phenomenon, as in damp hay-ricks, coal-dust, heaps of decaying vegetable matter, masses of rags or tow saturated with oil, &c. Bacon's explanation, it is unnecessary to say, is wholly unscientific. The following is given in Watts' Dictionary of Chemistry, art. Combustion: 'The substance absorbs and condenses the air within its pores; oxidation then commences immediately and raises the temperature, which again accelerates the oxidation; and thus the process goes on with continually increasing rapidity, till at length the mass bursts into flame. The low conducting power of such a porous mass greatly facilitates the combustion, by preventing the dissipation of the heat generated. * * * * The presence of moisture greatly promotes the spontaneous ignition of porous substances, such as hay or coal-dust, the water probably supplying oxygen to the combustible matter.' Where the masses are small, the heat developed is usually carried off; so that combustion, in materials of this character, is far more likely to take place in large masses than small. Thus, in a hay-rick the process may be arrested by pulling the rick to pieces.

19 The reason is that the water enters into combination with the quicklime, which has a powerful affinity for it, and that heat is developed in the process.

The word 'antiperistasis' is defined in ii. 27 ad fin. as 'rejectio naturae contrariae.' Cp. note on that passage.

apparebit, si loco aquae immittatur oleum [20]; oleum enim aeque ac aqua valebit ad unionem spiritus inclusi, sed non ad irritationem. Etiam faciendum est experimentum latius tam in cineribus et calcibus diversorum corporum, quam per immissionem diversorum liquorum.

Ad 19am 25a. Huic instantiae subjungitur *negativa* aliorum metallorum, quae sunt magis mollia et fluxa. Etenim bracteolae auri, solutae in liquorem per aquam regis, nullum dant calorem ad tactum in dissolutione; neque similiter plumbum in aqua forti; neque etiam argentum vivum (ut memini); sed argentum ipsum parum excitat caloris, atque etiam cuprum (ut memini), sed magis manifesto stannum, atque omnium maxime ferrum et chalybs, quae non solum fortem excitant calorem in dissolutione, sed etiam violentam ebullitionem. Itaque videtur calor fieri per conflictum, cum aquae fortes penetrant et fodiunt et divellunt partes corporis, et corpora ipsa resistunt [21]. Ubi vero corpora facilius cedunt, vix excitatur calor.

Ad 20am 26a. Calori animalium nulla subjungitur *negativa*, nisi insectorum (ut dictum est) ob parvitatem corporis. Etenim in piscibus collatis ad animalia terrestria magis notatur gradus caloris quam privatio. In vegetabilibus autem et plantis nullus percipitur gradus caloris ad tactum, neque in lachrymis ipsorum, neque in medullis recenter apertis. At in animalibus magna reperitur diversitas caloris, tum in partibus ipsorum (alius est enim calor circa cor, alius in cerebro, alius circa externa), tum in accidentibus eorum, ut in exercitatione vehementi et febribus.

Ad 21am 27a. Huic instantiae vix subjungitur *negativa*. Quinetiam excrementa animalium non recentia manifeste habent calorem potentialem, ut cernitur in impinguatione soli.

The reader will not fail to notice Bacon's curious use of the word 'spirit' and the strange metaphors which it suggests to him.

[20] Any water, which may be contained in the oil, will enter into combination with the quick-lime, but the pure oil will remain distinct.

[21] In these and similar cases, heat is developed by chemical action. 'I know of no exception,' says Sir W. R. Grove, 'to the general proposition that all bodies, in chemically combining, produce heat.' Correlation of Physical Forces, Section on Chemical Affinity.

Ad 22am et 23am 28a. Liquores (sive aquae vocentur sive olea) qui habent magnam et intensam acrimoniam exequuntur opera caloris in divulsione corporum, atque adustione post aliquam moram; sed tamen ad ipsum tactum manus non sunt calidi ab initio. Operantur autem secundum analogiam[22] et poros corporis cui adjunguntur. Aqua enim regis aurum solvit, argentum minime; at contra aqua fortis argentum solvit, aurum minime; neutrum autem solvit vitrum. Et sic de caeteris.

Ad 24am 29a. Fiat experimentum spiritus vini in lignis, ac etiam in butyro aut cera aut pice; si forte per calorem suum ea aliquatenus liquefaciat[23]. Etenim instantia 24a ostendit potestatem ejus imitativam caloris in incrustationibus. Itaque fiat similiter experimentum in liquefactionibus. Fiat etiam experimentum per vitrum graduum sive calendare quod concavum sit in summitate sua per exterius; et immittatur in illud concavum exterius spiritus vini bene rectificatus, cum operculo, ut melius contineat calorem suum; et notetur utrum per calorem suum faciat aquam descendere[24].

Ad 25am 30a. Aromata, et herbae acres ad palatum, multo magis sumptae interius, percipiuntur calida. Videndum itaque in quibus aliis materiis exequantur opera caloris. Atque referunt nautae, cum cumuli et massae aromatum diu conclusae subito aperiuntur, periculum instare illis, qui eas primo agitant et extrahunt, a febribus et inflammationibus spiritus. Similiter fieri poterit experimentum, utrum pulveres hujusmodi aromatum aut herbarum non arefaciant laridum et carnem suspensam super ipsos, veluti fumus ignis.

Ad 26am 31a. Acrimonia sive penetratio inest tam frigidis, qualia sunt acetum et oleum vitrioli, quam calidis, qualia sunt oleum

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22 It is not easy to see the exact meaning of this expression here. Does it mean vaguely 'according as they are related to the objects to which they are applied'?

23 'Spirits of wine will dissolve wax and pitch, but not wood or butter.' Mr. Kitchin's note.

24 The nature of this experiment will be made clear by consulting Inst. 38 of the next Aphorism. The water will descend owing to the expansion of the spirits of wine. The employment of Spirits of Wine in the construction of thermometers was intermediate between that of air and that of mercury.

origani et similia. Itaque similiter et in animatis cient dolorem, et in non animatis divellunt partes et consumunt. Neque huic instantiae subjungitur *negativa*. Atque in animatis nullus reperitur dolor, nisi cum quodam sensu caloris.

Ad 27am 32a. Communes sunt complures actiones et calidi et frigidi, licet diversa admodum ratione. Nam et nives puerorum manus videntur paulo post urere; et frigora tuentur carnes a putrefactione[25], non minus quam ignis; et calores contrahunt corpora in minus[26], quod faciunt et frigida. Verum haec et similia opportunius est referre ad Inquisitionem de Frigido[27].

XIII.

Tertio facienda est *comparentia ad intellectum* instantiarum in quibus natura, de qua fit inquisitio, inest secundum magis et minus; sive facta comparatione incrementi et decrementi in eodem subjecto, sive facta comparatione ad invicem in subjectis diversis. Cum enim forma rei sit ipsissima res[28]; neque differat res a forma, aliter quam differunt apparens et existens, aut exterius et interius, aut in ordine ad hominem et in ordine ad universum[29]; omnino sequitur ut non reci-

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[25] This remark is interesting, as connected with the experiment which was the occasion of Bacon's death. On a cold morning in the spring of 1626, he descended from his coach at the bottom of Highgate Hill, bought a hen of a poor woman, and stuffed it with snow. The chill, to which he was thus exposed, brought on an attack of what we should now call bronchitis, of which he died on the 9th of April.

[26] This effect, which is, of course, only apparent, is due to the escape of gases. With certain very rare exceptions, the invariable effect of any augmentation of temperature is to expand, not to contract, a body.

[27] As I have pointed out before, Bacon did not see the true relation of heat and cold, but regarded the latter as a positive quality. There is no systematic 'Inquisitio de Frigido' in his works. The nearest approaches to it are 'Experiments in consort touching the production of cold' in the Sylva Sylvarum, Century i. 69–75 (E. and S., vol. ii. pp. 370–1), and a Fragment entitled 'Sequela Cartarum, sive Inquisitio Legitima de Calore et Frigore' (E. and S., vol. iii. pp. 644–52).

[28] The language here used of Form exactly corresponds with that which might be used of the scholastic term 'Essence,' or of the 'Real Essence' of Locke. There is, perhaps, no passage in the Novum Organum, in which we could less appropriately replace the word by 'Law' or 'Cause.'

[29] This is only another way of stating the contrast of 'apparens' et 'existens,' of a thing or quality as it appears to us, and as it is in its

piatur aliqua natura pro vera forma, nisi perpetuo decrescat quando natura ipsa decrescit, et similiter perpetuo augeatur quando natura ipsa augetur [30]. Hanc itaque tabulam *Tabulam Graduum* sive *Tabulam Comparativae* appellare consuevimus.

Tabula Graduum sive *Comparativae* in Calido.

Primo itaque dicemus de iis quae nullum prorsus gradum caloris habent ad tactum, sed videntur habere potentialem tantum quendam calorem, sive dispositionem et praeparationem ad calidum. Postea demum descendemus ad ea quae sunt actu sive ad tactum calida, eorumque fortitudines et gradus.

1. In corporibus solidis et tangibilibus non invenitur aliquid quod in natura sua calidum sit originaliter [31]. Non enim lapis aliquis, non metallum, non sulphur, non fossile aliquod, non lignum, non aqua, non cadaver animalis, inveniuntur calida. Aquae autem calidae in balneis videntur calefieri per accidens, sive per flammam aut ignem subterraneum, qualis ex Aetna et montibus aliis compluribus evomitur, sive ex conflictu corporum, quemadmodum calor fit in ferri et stanni

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own inmost nature. Thus, heat, as affecting the senses, is 'in ordine ad hominem,' while its cause or essence, a motion of a certain kind amongst the minute particles of matter, is 'in ordine ad universum.' Aristotle's distinction of πρότερα or γνωριμώτερα πρὸς ἡμᾶς and πρότερα or γνωριμώτερα τῇ φύσει, as applied respectively to individuals and species, is, it will be noticed, here transferred to the relation of an effect to its cause or a phenomenon to its essence.

[30] This rule, so far as it affects the relation of cause and effect, is vitiated by the consideration of the Plurality of Causes. As an effect may be due to two or more distinct causes, being sometimes produced by one and sometimes by another, it is quite conceivable that one of the causes might remain altogether unchanged, while the effect increased or diminished concurrently with the other cause or with one of the other causes. This objection does not apply to the Canon of the Method of Concomitant Variations as stated by Mr. Mill or myself.

[31] What Bacon means is that there is no tangible body which, in its ordinary condition, affects the skin with the sensation of heat. The purely relative and negative character of 'cold,' and the laws of radiation and conduction, we must recollect, were alike unknown to him.

By 'cold' Bacon, of course, means a temperature lower than that of the skin.

dissolutionibus. Itaque gradus caloris in inanimatis, quatenus ad tactum humanum, nullus est; veruntamen illa gradu frigoris differunt; non enim aeque frigidum est lignum ac metallum. Sed hoc pertinet ad *Tabulam Graduum in Frigido.*

2. Attamen quoad potentiales calores et praeparationes ad flammam, complura inveniuntur inanimata admodum disposita, ut sulphur, naphtha, petrelaeum [32].

3. Quae antea incaluerunt, ut fimus equinus ex animali, aut calx, aut fortasse cinis aut fuligo ex igne, reliquias latentes quasdam caloris prioris retinent [33]. Itaque fiunt quaedam distillationes et separationes corporum per sepulturam in fimo equino; atque excitatur calor in calce per aspersionem aquae; ut jam dictum est.

4. Inter vegetabilia non invenitur aliqua planta sive pars plantae (veluti lachryma aut medulla) quae sit ad tactum humanum calida. Sed tamen (ut superius dictum est) herbae virides conclusae calescunt; atque ad interiorem tactum, veluti ad palatum aut ad stomachum aut etiam ad exteriores partes, post aliquam moram (ut in emplastris et unguentis) alia vegetabilia inveniuntur calida, alia frigida [34].

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[32] Petroleum.

[33] This idea is, of course, purely fantastic. By analogy, steel or glass ought to be peculiarly susceptible of heat, because they have been passed through the furnace.

[34] This confusion between things which are hot, in the true sense of having a high degree of temperature, and those which affect any of our organs with a sensation akin to that of heat, has already been pointed out in note 65 on Aph. 11. Sir John Herschel's remarks (Discourse on the study of Natural Philosophy, § 345) on this and similar confusions apply to so many of Bacon's examples that I think it will be useful to the student if I extract them at length:

'The word heat generally implies the sensation which we experience on approaching a fire; but, in the sense it carries in physics, it denotes the cause, whatever it be, of that sensation, and of all the other phenomena which arise on the application of fire, or of any other heating cause. We should be greatly deceived if we referred only to sensation as an indication of the presence of this cause. Many of those things which excite in our organs, and especially those of taste, a sensation of heat, owe this property to chemical stimulants, and not at all to their being actually *hot*. This error of judgment has produced a corresponding confusion of language, and hence had actually at one period crept into physical philosophy a great many illogical and absurd conclusions. Again, there

5. Non invenitur in partibus animalium, postquam fuerint mortuae aut separatae, aliquid calidum ad tactum humanum. Nam neque fimus equinus ipse, nisi fuerit conclusus et sepultus, calorem retinet. Sed tamen omnis fimus habere videtur calorem potentialem, ut in agrorum impinguatione. Et similiter, cadavera animalium hujusmodi habent latentem et potentialem calorem; adeo ut in coemeteriis, ubi quotidie fiunt sepulturae, terra calorem quendam occultum colligat, qui cadaver aliquod recenter impositum consumit longe citius quam terra pura [35]. Atque apud orientales traditur inveniri textile quoddam tenue et molle, factum ex avium plumagine, quod vi innata butyrum solvat et liquefaciat in ipso leviter involutum.

6. Quae impinguant agros, ut fimi omnis generis, creta, arena maris, sal, et similia, dispositionem nonnullam habent ad calidum.

7. Omnis putrefactio in se rudimenta quaedam exilis caloris habet [36], licet non hucusque ut ad tactum percipiatur. Nam nec ea ipsa quae putrefacta solvuntur in animalcula [37], ut caro, caseus, ad tactum percipiuntur calida; neque lignum putre,

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are a number of chemical agents, which, from their corroding, blackening, and dissolving, or drying up the parts of some descriptions of bodies, and producing on them effects not generally unlike (though intrinsically very different from) those produced by heat, are said, in loose and vulgar language, to burn them; and this error has even become rooted into a prejudice, by the fact that some of these agents are capable of becoming actually and truly *hot* during their action on moist substances, by reason of their combination with the water the latter contain. Thus, quicklime and oil of vitriol both exercise a powerful corrosive action on animal and vegetable substances, and both become violently hot by their combination with water. They are, therefore, set down in vulgar parlance as substances of a hot nature; whereas, in their relations to the physical cause of heat, they agree with the generality of bodies similarly constituted.'

[35] There is no ground, I believe, for this assertion. The idea may have been suggested by the effects of quick-lime, which was frequently strewn on corpses in time of plague, in hastening decomposition, not only at the time of being strewn but subsequently.

[36] This, as Mr. Ellis says, is true of eremacausis rather than of real putrefaction. For instances of the development of heat in the former process, see Inst. 23 of the last Aphorism and the note upon it.

[37] Bacon regarded putrefaction as a co-ordinate cause of generation with copulation. See Sylva Sylvarum, Experiment 900.

quod noctu splendet[38], deprehenditur ad tactum calidum. Calor autem in putridis quandoque se prodit per odores tetros et fortes.

8. Primus itaque caloris gradus, ex iis quae ad tactum humanum percipiuntur calida, videtur esse calor animalium, qui bene magnam habet graduum latitudinem. Nam infimus gradus (ut in insectis) vix ad tactum deprenditur; summus autem gradus vix attingit ad gradum caloris radiorum solis in regionibus et temporibus maxime ferventibus[39], neque ita acris est quin tolerari possit a manu. Et tamen referunt de Constantio[40], aliisque nonnullis qui constitutionis et habitus corporis admodum sicci fuerunt, quod acutissimis febribus correpti ita incaluerint ut manum admotam aliquantulum urere visi sint.

9. Animalia, ex motu et exercitatione, ex vino et epulis, ex venere, ex febribus ardentibus, et ex dolore, augentur calore.

10. Animalia, in accessibus febrium intermittentium, a principio frigore et horrore corripiuntur, sed paulo post majorem in modum incalescunt; quod etiam faciunt a principio in causonibus[41] et febribus pestilentialibus.

11. Inquiratur ulterius de calore comparato in diversis animalibus, veluti piscibus, quadrupedibus, serpentibus, avibus; atque etiam secundum species ipsorum, ut in leone, milvio, homine; nam ex vulgari opinione, pisces per interiora minus

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[38] This phenomenon, as already stated, is due to phosphorescence.

[39] Blood-Heat is marked at 98° Fahrenheit and Fever-Heat at 112° on the ordinary Thermometers. These are considerably below the number of degrees which the Thermometer sometimes marks in the sun even in temperate climates.

[40] The person alluded to is Constantius II, son of Constantine the Great. Mr. Ellis refers to Ammianus Marcellinus, lib. xxi. cap. 15. The passage runs as follows: 'paullatimque urente calore nimio venas, ut ne tangi quidem corpus ejus posset in modum foculi fervens, cum usus deficeret medullarum, ultimum spirans deflebat exitium.'

[41] The word καύσων is employed in the New Testament to express a burning, scorching heat, as in Matt. xx. 12, Luke xii. 55, James i. 11. In the Septuagint, it generally means the East Wind, as being the wind which brings hot and scorching weather. Here it must be employed as the equivalent of καῦσος, a bilious, intermittent fever.

calidi sunt, aves autem maxime calidae; praesertim columbae, accipitres, struthiones[42].

12. Inquiratur ulterius de calore comparato in eodem animali, secundum partes et membra ejus diversa. Nam lac, sanguis, sperma, ova, inveniuntur gradu modico tepida, et minus calida quam ipsa caro exterior in animali quando movetur aut agitatur. Qualis vero gradus sit caloris in cerebro, stomacho, corde, et reliquis, similiter adhuc non est quaesitum.

13. Animalia omnia, per hyemem et tempestates frigidas, secundum exterius frigent; sed per interiora etiam magis esse calida existimantur.

14. Calor coelestium, etiam in regione calidissima atque temporibus anni et diei calidissimis, non eum gradum caloris obtinet, qui vel lignum aridissimum vel stramen vel etiam linteum ustum incendat aut adurat, nisi per specula comburentia roboretur; sed tamen e rebus humidis vaporem excitare potest.

15. Ex traditione astronomorum ponuntur stellae aliae magis, aliae minus calidae[43]. Inter planetas enim post solem ponitur Mars calidissimus, deinde Jupiter, deinde Venus; ponuntur autem tanquam frigidi Luna et deinde omnium maxime Saturnus. Inter fixas autem ponitur calidissimus Sirius[44], deinde Cor Leonis, sive Regulus[45], deinde Canicula[46], etc.

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[42] The word 'struthio,' which commonly means an ostrich, is, Mr. Spedding supposes, here used for a sparrow.

[43] The order here adopted is, of course, with the exception of the sun, purely fanciful. The 'tradition,' with regard to the planets, was probably founded on their aspect, i.e. their colour and brilliancy; with regard to the fixed stars, partly on their brilliancy, partly on some peculiarity in their relative position in the heavens, partly on the period of their heliacal rising.

It may be noticed that the Sun is ranked amongst the Planets.

On the influence, generally, of the heavenly bodies on the seasons and weather, see Pliny, Natural History, bk. ii. chs. 39–41. sects. 105–10.

[44] *α* Canis Majoris. We can hardly be surprised at the notion of intense heat being connected with Sirius. Not only is it far the most brilliant of the fixed stars, but the period of its heliacal rising corresponds with the hottest time of the year, whence the expression 'Dies Caniculares' or 'Dog-Days.' It is frequently alluded to by the ancients, as in the well-known lines of Homer and Virgil:

16. Sol magis calefacit, quo magis vergit ad perpendiculum sive Zenith, quod etiam credendum est de aliis planetis, pro modulo suo caloris; exempli gratia, Jovem magis apud nos calefacere, cum positus sit sub Cancro aut Leone quam sub Capricorno aut Aquario.

17. Credendum est solem ipsum et planetas reliquos magis calefacere in perigaeis suis, propter propinquitatem ad terram, quam in apogaeis[47]. Quod si eveniat ut in aliqua regione sol

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Τὸν δ' ὁ γέρων Πρίαμος πρῶτος ἴδεν ὀφθαλμοῖσιν,
παμφαίνονθ' ὥστ' ἀστέρ', ἐπεσσύμενον πεδίοιο,
ὅς ῥά τ' ὀπώρης εἶσιν, ἀρίζηλοι δέ οἱ αὐγαὶ
φαίνονται πολλοῖσι μετ' ἀστράσι νυκτὸς ἀμολγῷ·
ὅντε κύν' Ὠρίωνος ἐπίκλησιν καλέουσιν.
λαμπρότατος μὲν ὅδ' ἐστί, κακὸν δέ τε σῆμα τέτυκται,
καί τε φέρει πολλὸν πυρετὸν δειλοῖσι βροτοῖσιν.

Il. xxii. 25–31. (Cp. v. 5, 6.)

'Non secus, ac liquida si quando nocte cometae
Sanguinei lugubre rubent, aut Sirius ardor,
Ille sitim morbosque ferens mortalibus aegris,
Nascitur et laevo contristat lumine coelum.'

Aen. x. 272–5. (Cp. Georg. iv. 425–8; Aen. iii. 141–2.)

Pliny (Nat. Hist. ii. 40. sect. 107) has an interesting description of the supposed effects of the star, which is there called 'Canicula.'

'Nam Caniculae exortu accendi Solis vapores quis ignorat? cujus sideris effectus amplissimi in terra sentiuntur. Fervent maria exoriente eo, fluctuant in cellis vina, moventur stagna. Orygem appellat Aegyptus feram, quam in exortu ejus contra stare, et contueri tradit, ac velut adorare, cum sternuerit. Canes quidem toto eo spatio maxime in rabiem agi, non est dubium.'

A tolerably full account of Sirius, or Canicula as it was sometimes called, is given in Smyth's Celestial Cycle, vol. ii. p. 158, &c.

[45] *a* Leonis. See Smyth's Celestial Cycle, vol. ii. p. 225, &c. 'Ptolemy calls this star Βασιλίσκος, from an opinion of its influencing the affairs of the heavens; whence comes its Latin name Regulus.'

[46] *a* Canis Minoris. See Smyth, vol. ii. pp. 182–3. This star is also called Προκύων, because it appears in the morning dawn, as the precursor of Sirius. The 'Lesser Dog' or 'Little Dog' is a star of great brilliancy, though not nearly so brilliant as Sirius or the 'Greater Dog.'

Horace refers to this star and Regulus in the well-known lines:

'Jam clarus occultum Andromedae pater
Ostendit ignem: jam Procyon furit,
Et stella vesani Leonis,
Sole dies referente siccos.'

Od. iii. 29 (17–20).

[47] The furthest and nearest distances between the earth and sun are,

sit simul in perigaeo et propius ad perpendiculum, necesse est ut magis calefaciat quam in regione ubi sol sit similiter in perigaeo sed magis ad obliquum. Adeo ut comparatio exaltationis planetarum notari debeat, prout ex perpendiculo aut obliquitate participet, secundum regionum varietatem.

18. Sol etiam, et similiter reliqui planetae, calefacere magis existimantur cum sint in proximo ad stellas fixas majores; veluti cum sol ponitur in Leone, magis vicinus fit Cordi Leonis, Caudae Leonis, et Spicae Virginis, et Sirio, et Caniculae, quam cum ponitur in Cancro, ubi tamen magis sistitur ad perpendiculum[48]. Atque credendum est partes coeli majorem infundere calorem (licet ad tactum minime perceptibilem) quo magis ornatae sint stellis, praesertim majoribus.

19. Omnino calor coelestium augetur tribus modis; videlicet ex perpendiculo, ex propinquitate sive perigaeo, et ex conjunctione sive consortio stellarum.

20. Magnum omnino invenitur intervallum inter calorem animalium ac etiam radiorum coelestium (prout ad nos deferuntur), atque flammam, licet lenissimam, atque etiam ignita omnia, atque insuper liquores, aut aërem ipsum majorem in modum ab igne calefactum. Etenim flamma spiritus vini, praesertim rara nec constipata, tamen potis est stramen aut linteum aut papyrum incendere; quod nunquam faciet calor animalis vel solis, absque speculis comburentibus[49].

21. Flammae autem et ignitorum plurimi sunt gradus in

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of course, in the Copernican system described as aphelion and perihelion, not as apogee and perigee. The variations of distance from the sun, due to the elliptic orbit of the earth, have, as a matter of fact, little influence in determining temperature, being compensated by the variations in the angular velocity. Were it not for this fact, the summers and winters would be intensified in the southern, and moderated in the northern hemisphere.

For an explanation of the phenomena of the seasons, see Herschel's Astronomy (4th Ed., § 362–369).

[48] This is an attempt to account for July being hotter than the time of the summer solstice. The true reason is, of course, the same as that for the early afternoon being hotter than noon-day, namely, the increased radiation of heat from the earth's surface.

[49] And yet, in parts of Australia and South Africa, during summer, a lucifer match accidentally falling on the ground will ignite. See Herschel's Astronomy, § 369.

fortitudine et debilitate caloris[50]. Verum de his nulla est facta diligens inquisitio; ut necesse sit ista leviter transmittere. Videtur autem ex flammis illa ex spiritu vini esse mollissima; nisi forte ignis fatuus, aut flammae seu coruscationes ex sudoribus animalium, sint molliores. Hanc sequi opinamur flammam ex vegetabilibus levibus et porosis, ut stramine, scirpis, et foliis arefactis, a quibus non multum differre flammam ex pilis aut plumis. Hanc sequitur fortasse flamma ex lignis, praesertim iis quae non multum habent ex resina aut pice; ita tamen ut flamma ex lignis quae parva sunt mole (quae vulgo colligantur in fasciculos) lenior sit quam quae fit ex truncis arborum et radicibus. Id quod vulgo experiri licet in fornacibus quae ferrum excoquunt, in quibus ignis ex fasciculis et ramis arborum non est admodum utilis[51]. Hanc sequitur (ut arbitramur) flamma ex oleo et sevo et cera, et hujusmodi oleosis et pinguibus, quae sunt sine magna acrimonia. Fortissimus autem calor reperitur in pice et resina; atque adhuc magis in sulphure et caphura[52], et naphtha et petrelaeo et salibus (postquam materia cruda eruperit), et in horum compositionibus, veluti pulvere tormentario, igne Graeco[53] (quem vulgo ignem ferum vocant), et diversis ejus generibus, quae tam obstinatum habent calorem ut ab aquis non facile exstinguantur.

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[50] It is almost unnecessary to remark that the order in which Bacon arranges the temperature of flames bears hardly any relation to the conclusions established by modern physicists. He was partly, no doubt, deceived by the luminosity or illuminating power of flames, which is often very low, when the temperature is very high. Thus, for instance, a hydrogen flame, which is the palest of all, gives out the greatest heat.

A good account of the nature of Flame is given in Miller's Elements of Chemistry, Part ii. In Ganot's Physics (Translation, 6th Ed., § 448) there is a table of the relative quantities of heat disengaged by various bodies during combustion. Marsh-gas comes next to hydrogen in this list, while spirits of wine is relatively high and sulphur relatively low.

[51] The quantity of heat disengaged by moist wood during combustion is much less than that disengaged by dry wood.

[52] Camphor.

[53] Not to be confounded with gunpowder. 'It was known in the east of Europe as early as the year A.D. 673, when, it is said, Callinicus, an architect of Heliopolis, taught the use of it to the Greeks. It did not reach the west of Europe till much later.' Brande and Cox's Dictionary of Science, &c.

22. Existimamus etiam flammam, quae resultat ex nonnullis metallis imperfectis[54], esse valde robustam et acrem. Verum de istis omnibus inquiratur ulterius.

23. Videtur autem flamma fulminum potentiorum[55] has omnes flammas superare; adeo ut ferrum ipsum perfectum aliquando colliquaverit in guttas, quod flammae illae alterae facere non possunt.

24. In ignitis autem diversi sunt etiam gradus caloris, de quibus etiam non facta est diligens inquisitio. Calorem maxime debilem existimamus esse ex linteo usto, quali ad flammae excitationem uti solemus; et similiter ex ligno illo spongioso[56] aut funiculis arefactis qui ad tormentorum accensionem adhibentur. Post hunc sequitur carbo ignitus ex lignis et anthracibus, atque etiam ex lateribus ignitis, et similibus. Ignitorum autem vehementissime calida existimamus esse metalla ignita, ut ferrum et cuprum et caetera. Verum de his etiam facienda est ulterior inquisitio.

25. Inveniuntur ex ignitis nonnulla longe calidiora quam nonnullae ex flammis. Multo enim calidius est et magis adurens ferrum ignitum quam flamma spiritus vini.

26. Inveniuntur etiam ex illis quae ignita non sunt sed tantum ab igne calefacta, sicut aquae ferventes et aër conclusus in reverberatoriis, nonnulla quae superant calore multa ex flammis ipsis et ignitis.

27. Motus auget calorem[57]; ut videre est in follibus et flatu; adeo ut duriora ex metallis non solvantur aut liquefiant per ignem mortuum aut quietum, nisi flatu excitetur.

28. Fiat experimentum per specula comburentia, in quibus

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[54] He probably means what were commonly called the baser or viler, as opposed to the more precious metals (gold and silver). Thus, in the Catalogus Historiarum Particularium, published at the end of the first edition of the Novum Organum, he enumerates 'Historia Metallorum perfectorum, Auri, Argenti' (E. and S., vol. i. p. 406). It is possible, however, that he may mean 'metals while being smelted in the furnace.' See the expression 'ferrum ipsum perfectum' in the next instance.

[55] As opposed to sheet-lightning. See ii. 12. Inst. 9.

[56] Touchwood.

[57] 'By supplying a greater quantity of oxygen from the air. It is not mere motion, for the manufacturer, who tried to blow his fires by means of steam jets, simply blew them out.' Mr. Kitchin's note.

(ut memini) hoc fit; ut si speculum ponatur (exempli gratia) ad distantiam spithamae ab objecto combustibili, non tantopere incendat aut adurat quam si positum fuerit speculum (exempli gratia) ad distantiam semi-spithamae, et gradatim et lente trahatur ad distantiam spithamae. Conus tamen et unio radiorum eadem sunt, sed ipse motus auget operationem caloris[58].

29. Existimantur incendia illa, quae fiunt flante vento forti, majores progressus facere adversus ventum quam secundum ventum; quia scilicet flamma resilit motu perniciore, vento remittente, quam procedit, vento impellente[59].

30. Flamma non emicat aut generatur, nisi detur aliquid concavi in quo flamma movere possit et ludere[60]; praeterquam in flammis flatuosis pulveris tormentarii, et similibus, ubi compressio et incarceratio flammae auget ejus furorem[61].

31. Incus per malleum calefit admodum; adeo ut si incus fuerit laminae tenuioris, existimemus illam per fortes et continuos ictus mallei posse rubescere, ut ferrum ignitum[62]; sed de hoc fiat experimentum.

32. At in ignitis quae sunt porosa, ita ut detur spatium ad exercendum motum ignis, si cohibeatur hujusmodi motus per compressionem fortem, statim extinguitur ignis; veluti cum

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[58] The only explanation of this curious supposition, as Mr. Ellis suggests, is that the focal length of the lens lay between a span and half a span, and was found by moving the lens. Bacon's remark, it must be confessed, betrays great ignorance of the laws of Optics.

[59] Here the fact is inaccurately stated, and the reason assigned fanciful. In a fire, however, the flames will burn most brightly where the wind is highest (provided it is not sufficiently violent to put them out), the reason being that fresh supplies of oxygen are being constantly brought into contact with the ignited mass.

[60] In ordinary cases, a supply of oxygen is essential to combustion, and, therefore, there must be contact with the air. 'But combustion does not necessarily involve the presence of oxygen. If either powdered antimony or a fragment of phosphorus be placed in a vessel of chlorine, it unites with chlorine, producing thereby heat and flame.' Ganot's Physics, 6th Ed., p. 385.

[61] In this case, the supply of oxygen is derived from the saltpetre. It is, perhaps, needless to add that the *amount* of explosion is exactly the same in the gun as it would be in the open air.

[62] This would be so. Bacon was here on the right track for discovering the connection between heat and motion.

linteum ustum aut filum ardens candelae aut lampadis aut etiam carbo aut pruna ardens comprimitur per pressorium aut pedis conculcationem aut hujusmodi, statim cessant operationes ignis.

33. Approximatio ad corpus calidum auget calorem, pro gradu approximationis; quod etiam fit in lumine: nam quo propius collocatur objectum ad lumen eo magis est visibile[62].

34. Unio calorum diversorum auget calorem, nisi facta sit commistio corporum. Nam focus magnus et focus parvus in eodem loco nonnihil invicem augent calorem; at aqua tepida immissa in aquam ferventem refrigerat.

35. Mora corporis calidi auget calorem. Etenim calor perpetuo transiens et emanans commiscetur cum calore praeinexistente, adeo ut multiplicet calorem. Nam focus non aeque calefacit cubiculum per moram semihorae ac si idem focus duret per horam integram. At hoc non facit lumen; etenim lampas aut candela in aliquo loco posita non magis illuminat per moram diuturnam quam statim ab initio.

36. Irritatio per frigidum ambiens auget calorem; ut in focis videre est per gelu acre[63]. Quod existimamus fieri non tantum per conclusionem et contractionem caloris, quae est species unionis, sed per exasperationem; veluti cum aër aut baculum violenter comprimitur aut flectitur, non ad punctum loci prioris resilit, sed ulterius in contrarium. Itaque fiat diligens experimentum per baculum vel simile aliquid immissum

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[62] 'To the eye of the philosopher these obscure radiations' (namely, of heat) 'are precisely the same in kind, as those which produce the impression of light. You must, therefore, figure the particles of the heated body as in a state of motion; you must figure that motion as communicated to the surrounding ether, and transmitted through it with a velocity, which we have the strongest reason for believing to be the same as that of light.' Tyndall's Heat a Mode of Motion, § 306. The law of the intensity of radiant heat on a given surface is the same as that of illumination, that is to say, it varies inversely as the square of the distance from the source of heat, as the other from the source of light.

[63] This circumstance is mainly due to the increased draught produced by the difference between the temperatures of the internal and external air, and perhaps, to some extent, also by the increased dryness of the atmosphere.

The ideas of exasperation and irritation, as applied to these phenomena, are peculiarly fanciful.

in flammam, utrum ad latera flammae non uratur citius quam in medio flammae.

37. Gradus autem in susceptione caloris sunt complures. Atque primo omnium notandum est, quam parvus et exilis calor etiam ea corpora, quae caloris minime omnium sunt susceptiva, immutet tamen et nonnihil calefaciat. Nam ipse calor manus globulum plumbi aut alicujus metalli paulisper detentum nonnihil calefacit. Adeo facile et in omnibus transmittitur et excitatur calor, corpore nullo modo ad apparentiam immutato.

38. Facillime omnium corporum apud nos et excipit et remittit calorem aër[64]; quod optime cernitur in vitris calendaribus. Eorum confectio est talis[65]: accipiatur vitrum ventre concavo, collo tenui et oblongo; resupinetur et demittatur hujusmodi vitrum, ore deorsum verso, ventre sursum, in aliud vasculum vitreum ubi sit aqua, tangendo fundum vasculi illius recipientis extremo ore vitri immissi, et incumbat paullulum vitri immissi collum ad os vitri recipientis, ita ut stare possit; quod ut commodius fiat, apponatur parum cerae ad os vitri recipientis; ita tamen ut non penitus obturetur os ejus, ne ob defectum aëris succedentis impediatur motus de quo jam dicetur, qui est admodum facilis et delicatus.

Oportet autem ut vitrum demissum, antequam inseratur in alterum, calefiat ad ignem a parte superiori, ventre scilicet.

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[64] As I have before said, air is a bad conductor of heat. It was on account of its expansive and not on account of its conductive capacity that it served roughly as a thermometer, before the substitution, first of alcohol, and then of mercury.

[65] Mr. Ellis remarks: 'I am very much inclined to think that Bacon heard of the vitrum calendare from Fludde, or à Fluctibus, as he is called in Latin, who returned from Italy in [1605], and in whose philosophy, built upon certain abstract notions of rarefaction and condensation, perpetual reference is made to the air-thermometer, to which he gives the same name.'

As I have already noticed in note 82 on the last Aphorism, the invention of the thermometer has been ascribed to several persons, including Galileo, Drebbel, and, though on insufficient grounds, even Bacon himself. See also Introduction, p. 43, n. 15. Mr. Ellis has a long note on the invention of the Thermometer (vol. i. p. 255. n. 1). To this, which is too long for quotation, I must refer the reader who is specially interested in the question.

Postquam autem fuerit vitrum illud collocatum, ut diximus, recipiet et contrahet se aër (qui dilatatus erat per calefactionem), post moram sufficientem pro extinctione illius ascititii caloris, ad talem extensionem sive dimensionem qualis erit aëris ambientis aut communis tunc temporis quando immittitur vitrum, atque attrahet aquam in sursum ad hujusmodi mensuram. Debet autem appendi charta angusta et oblonga, et gradibus (quot libuerit) interstincta. Videbis autem, prout tempestas diei incalescit aut frigescit, aërem se contrahere in angustius per frigidum et extendere se in latius per calidum; id quod conspicietur per aquam ascendentem quando contrahitur aër, et descendentem sive depressum quando dilatatur aër. Sensus autem aëris, quatenus ad calidum et frigidum, tam subtilis est et exquisitus ut facultatem tactus humani multum superet; adeo ut solis radius aliquis, aut calor anhelitus, multo magis calor manus, super vitri summitatem positus, statim deprimat aquam manifesto. Attamen existimamus spiritum animalium[66] magis adhuc exquisitum sensum habere calidi et frigidi, nisi quod a mole corporea impediatur et hebetetur.

39. Post aërem, existimamus corpora esse maxime sensitiva caloris ea quae a frigore recenter immutata sint et compressa, qualia sunt nix et glacies; ea enim leni aliquo tepore solvi incipiunt et colliquari. Post illa sequitur fortasse argentum vivum. Post illud sequuntur corpora pinguia, ut oleum, butyrum, et similia; deinde lignum; deinde aqua; postremo lapides et metalla, quae non facile calefiunt, praesertim interius[67]. Illa tamen calorem semel susceptum diutissime retinent; ita ut later aut lapis aut ferrum ignitum in pelvim aquae frigidae

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[66] This remark is in accordance with Bacon's ordinary conception of 'spirit,' and especially of 'vital spirit,' as the most refined and delicate of all substances. In the Historia Vitae et Mortis (E. and S., vol. ii. p. 215) he regards 'vital spirit' as composed of air and flame. 'Alterum discrimen inter spiritus est; quod spiritus vitalis nonnullam habeat incensionem, atque sit tanquam aura composita ex flamma et aere.'

[67] On the different powers of conducting heat possessed by different bodies, see Tyndall's Heat a Mode of Motion, 2nd Ed., §§ 244-250. As a general rule, metals are the best conductors of heat. This is pre-eminently the case with silver and copper. Iron is comparatively a bad conductor.

immissum et demersum, per quartam partem horae (plus minus) retineat calorem, ita ut tangi non possit.

40. Quo minor est corporis moles, eo citius per corpus calidum approximatum incalescit[68]; id quod demonstrat omnem calorem apud nos esse corpori tangibili quodammodo adversum.

41. Calidum, quatenus ad sensum et tactum humanum, res varia est et respectiva: adeo ut aqua tepida, si manus frigore occupetur, sentiatur esse calida; sin manus incaluerit, frigida.

XIV.

Quam inopes simus historiae quivis facile advertet, cum in tabulis superioribus, praeterquam quod loco historiae probatae et instantiarum certarum nonnunquam traditiones et relationes inseramus (semper tamen adjecta dubiae fidei et auctoritatis nota), saepenumero etiam hisce verbis, *fiat experimentum*, vel *inquiratur ulterius*, uti cogamur[69].

XV.

Atque opus et officium harum trium tabularum *Comparentiam instantiarum ad intellectum* vocare consuevimus. Facta autem *comparentia*, in opere ponenda est ipsa *inductio*. Invenienda est enim, super *comparentiam* omnium et singularum instantiarum, natura talis, quae cum natura data perpetuo adsit, absit[70], atque crescat, et decrescat; sitque (ut superius

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[68] In other words, the conduction of heat requires time, which is undoubtedly true.

[69] In criticising Bacon's instances, this apology should be borne in mind. He ought, at least, to have the benefit of having been aware of the insufficiency and untrustworthiness of his own data. Cp. i. 117.

[70] If *both* these conditions were satisfied, the case would fall under the Double Method of Agreement, or Joint Method of Agreement and Difference, as it is variously called. It would not then be subject to the characteristic imperfection of the Method of Agreement, arising from Plurality of Causes, as would happen if we were simply able to establish the concomitance of the nature in question ('natura talis') and the 'natura data.' See notes on Aph. 4 and note 30 on beginning of Aph. 13. Moreover, if *both* conditions were satisfied, it would be proved that the ascertained cause was not only *a* cause but *the only* cause of the given phenomenon.

On the Double Method of Agreement, and its relation to the question of Plurality of Causes, the student may refer to the Editor's Inductive Logic.

dictum est) limitatio naturæ magis communis[71]. Hoc si mens jam ab initio facere tentet affirmative[72] (quod sibi permissa semper facere solet), occurrent phantasmata et opinabilia et notionalia male terminata et axiomata quotidie emendanda; nisi libeat (scholarum more) pugnare pro falsis[73]. Ea tamen proculdubio erunt meliora aut praviora pro facultate et robore intellectus qui operatur. At omnino Deo (formarum inditori et opifici) aut fortasse angelis et intelligentiis competit formas per affirmationem immediate nosse, atque ab initio contemplationis. Sed certe supra hominem est; cui tantum conceditur, procedere primo per *negativas*, et postremo loco desinere in *affirmativas*, post omnimodam exclusionem.

XVI.

Itaque naturae facienda est prorsus solutio et separatio; non per ignem certe, sed per mentem, tanquam ignem divinum. Est itaque *inductionis* verae opus primum (quatenus ad inveniendas formas) *rejectio* sive *exclusiva* naturarum singularum, quae non inveniuntur in aliqua instantia, ubi natura data adest[74]; aut inveniuntur in aliqua instantia, ubi natura data abest[75]; aut inveniuntur in aliqua instantia crescere, cum natura data decrescat[76]; aut decrescere, cum

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[71] See Aph. 4. The 'form' is here regarded as = differentia, that which added to the genus, or common nature, gives its distinctive character to the nature in question. Bacon illustrates his meaning in Aph. 20, where several 'differentiae' are proposed as limiting 'motus,' which is described as 'instar generis ad calorem.'

[72] Cp. i. 46, 105.

[73] Alluding to the scholastic disputations, in which both sides of a question were defended, however false or heretical one of them might be regarded as being.

[74] Owing to the Plurality of Causes, the 'given nature' might be present without the other 'nature,' even though this last was one of the causes capable of producing it. For it might not be the only cause, and, in this particular instance, the 'given nature' might be due to some other cause. Hence, the 'rejection' might be unwarranted.

On the Method of Exclusions or Rejections generally, see Introduction, § 9.

[75] As a cause must produce its effect, unless there be some counteracting cause, the 'rejection,' with this qualification, is warranted.

[76] The same remark applies to this case as to the last.

natura data crescat[77]. Tum vero post *rejectionem* et *exclusivam* debitis modis factam, secundo loco (tanquam in fundo) manebit (abeuntibus in fumum opinionibus volatilibus) forma affirmativa, solida, et vera[78], et bene terminata. Atque hoc breve dictu est, sed per multas ambages ad hoc pervenitur. Nos autem nihil fortasse ex iis, quae ad hoc faciunt, praetermittemus.

XVII.

Cavendum autem est, et monendum quasi perpetuo, ne, cum tantae partes formis videantur a nobis tribui, trahantur ea, quae dicimus, ad formas eas, quibus hominum contemplationes et cogitationes hactenus assueverunt[79].

Primo enim, de formis copulatis[80], quae sunt (ut diximus) naturarum simplicium conjugia ex cursu communi universi, ut leonis, aquilae, rosae, auri, et hujusmodi, impraesentiarum non loquimur. Tempus enim erit de iis tractandi, cum ventum fuerit ad *latentes processus*, et *latentes schematismos*, eorumque inventionem, prout reperiuntur in substantiis (quas vocant) seu naturis concretis[81].

Rursus vero, non intelligantur ea quae dicimus (etiam quatenus ad naturas simplices) de formis et ideis abstractis[82],

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[77] Here again, owing to the consideration of the Plurality of Causes, the 'rejection' might not be justified. Thus, the mortality of a town might increase, while a pestilence was diminishing, providing famine, war, or any other cause of death supervened.

The objection founded on Plurality of Causes, of course, only applies so far as 'Form' is intended to express the same idea as Cause. There can only be one 'essence,' or, in the strict sense of the terms, only one 'differentia' (that is, sum of characteristics) or 'definition' of an object or quality.

[78] That is, provided all possible causes have been considered, and the rejection has been so exhaustive, that only one cause remains—conditions which it is almost impossible to fulfil.

[79] Cp. i. 51, 65.

[80] These are the forms of concrete substances, and, as concrete substances are supposed to be constituted by a number of qualities or 'simple natures,' their forms will be the aggregate of the forms of the simple natures of which they are composed. See Aph. 5 ad init. to which Bacon here refers.

[81] Bacon had intended to proceed to these enquiries in a subsequent part of the Novum Organum. See Aph. 21 ('de variatione inquisitionis pro natura subjecti') and the last paragraph of Aph. 52.

[82] Referring to the ἰδέαι of Plato and the Forms of the Schoolmen. This

aut in materia non determinatis [83], aut male determinatis. Nos enim, quum de formis loquimur, nil aliud intelligimus quam leges illas et determinationes actus puri, quae naturam aliquam simplicem ordinant et constituunt, ut calorem, lumen, pondus, in omnimoda materia et subjecto susceptibili. Itaque eadem res est forma calidi aut forma luminis, et lex calidi sive lex luminis; neque vero a rebus ipsis et parte operativa unquam nos abstrahimus aut recedimus. Quare cum dicimus (exempli gratia) in inquisitione formae caloris, *Rejice tenuitatem*, aut *Tenuitas non est ex forma caloris;* idem est ac si dicamus, *Potest homo superinducere calorem in corpus densum*, aut contra, *Potest homo auferre aut arcere calorem a corpore tenui.*

Quod si cuiquam videantur etiam formae nostrae habere nonnihil abstracti, quod misceant et conjungant heterogenea (videntur enim valde esse heterogenea calor coelestium, et ignis; rubor fixus in rosa aut similibus, et apparens in iride aut radiis opalii aut adamantis; mors ex summersione, ex crematione, ex punctura gladii, ex apoplexia, ex atrophia; et tamen conveniunt ista in natura calidi, ruboris, mortis), is se habere intellectum norit consuetudine et integralitate [84] rerum et opinionibus captum et detentum. Certissimum enim est ista, utcunque heterogenea et aliena, coire in formam [85]

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paragraph seems to be nothing more than an expansion of the latter part of i. 51, on which see the notes.

This is one of the passages in which 'Form' appears to be most unequivocally used in the sense of 'Law' or 'Cause.'

[83] Cp. De Augm. iii. 4 (E. and S., vol. i. p. 565): 'At manifestum est, Platonem, virum sublimis ingenii (quique veluti ex rupe excelsa omnia circumspiciebat), in sua de Ideis doctrina *Formas esse verum scientiae objectum* vidisse; utcunque sententiae hujus verissimae fructum amiserit, Formas penitus a Materia abstractas, non in Materia determinatas, contemplando et prensando; unde factum est, ut ad speculationes theologicas diverteret, quod omnem naturalem suam philosophiam infecit et polluit.'

[84] The vague, general, or superficial appearances of things.

[85] It almost seems from this passage as if Bacon had anticipated the objections to his methods, based on the consideration of the Plurality of Causes. But here, as elsewhere, his vague and vacillating use of the word 'Form' makes it exceedingly difficult to attach a precise meaning to his language. It is undeniable, for instance, that the 'nature' of heat, that which constitutes it, its 'essence,' as the Schoolmen would have said, is the same in all cases; or else we should require two or more distinct words to

sive legem eam, quae ordinat calorem, aut ruborem, aut mortem; nec emancipari posse potentiam humanam et liberari a naturae cursu communi, et expandi et exaltari ad efficientia nova et modos operandi novos, nisi per revelationem et inventionem hujusmodi formarum; et tamen post istam unionem naturae, quae est res maxime principalis, de naturae divisionibus et venis, tam ordinariis quam interioribus et verioribus, suo loco postea dicetur.

XVIII.

Jam vero proponendum est exemplum *exclusionis* sive *rejectionis* naturarum, quae per *tabulas comparentiae* reperiuntur non esse ex forma calidi; illud interim monendo, non solum sufficere singulas *tabulas* ad *rejectionem* alicujus naturae, sed etiam unamquamque ex instantiis singularibus in illis contentis. Manifestum enim est ex iis, quae dicta sunt, omnem *instantiam contradictoriam* destruere opinabile de

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express the phenomenon. But its efficient causes, the agencies which produce it, may be, and are, several, as, for instance, friction, chemical combination, electricity, &c. Hence, where by 'form' Bacon means, as I think he usually does, 'nature,' there is only one form, and to the question, for example, What is heat? there is, and only can be, one answer. But, where by 'form' he means 'law' or 'cause,' there may be many forms; thus there are, for example, in this sense, as many forms of heat as there are distinct modes of its production. At the same time, we must remember that if the word 'form' with Bacon is vague and obscure, the word 'law' is so also, and we are not always justified in assuming that the latter word is employed by him in the same sense in which it is usually employed by us. The 'law' of an object or quality may be what we sometimes call the 'law of its being,' and thus not differ really from its 'nature.' To add, therefore, to our perplexity with reference to Bacon's employment of the word 'form,' we can seldom be quite certain in which of its two senses, nature or essence, and law or cause, he is using it; and, in fact, sometimes he seems to be using it in both at once. For a further discussion of this subject, see Introduction, § 8. The objections founded on the consideration of the Plurality of Causes would, of course, not apply to 'Form' employed as = Nature. But it need hardly be remarked that a philosophy which confined itself to investigating the 'natures' or 'essences' of things, without taking any account of their causes or the laws which determine their production, would be exceedingly defective on the side of both knowledge and practice.

forma[86]. Sed nihilominus quandoque perspicuitatis causa, et ut usus *tabularum* clarius demonstretur, *exclusivam* duplicamus aut repetimus.

Exemplum *exclusivae*, sive *rejectionis naturarum* a forma calidi.

1. Per radios solis, *rejice* naturam elementarem[87].
2. Per ignem communem, et maxime per ignes subterraneos (qui remotissimi sunt, et plurimum intercluduntur a radiis coelestibus), *rejice* naturam coelestem.
3. Per calefactionem omnigenum corporum (hoc est, mineralium, vegetabilium, partium exteriorum animalium, aquae, olei, aëris, et reliquorum) ex approximatione sola ad ignem aut aliud corpus calidum, *rejice* omnem varietatem sive subtiliorem texturam corporum.
4. Per ferrum et metalla ignita, quae calefaciunt alia corpora, nec tamen omnino pondere aut substantia minuuntur, *rejice* inditionem sive mixturam substantiae alterius calidi.
5. Per aquam ferventem atque aërem, atque etiam per metalla et alia solida calefacta, sed non usque ad ignitionem sive ruborem, *rejice* lucem et lumen[88].
6. Per radios lunae et aliarum stellarum (excepto sole), *rejice* etiam lucem et lumen.
7. Per *comparativam* ferri igniti et flammae spiritus vini (ex quibus ferrum ignitum plus habet calidi et minus lucidi, flamma autem spiritus vini plus lucidi et minus calidi[89]), *rejice* etiam lucem et lumen.

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[86] Cp. notes on Aph. 16. These will show the qualifications with which Bacon's assertion must be taken.

[87] That is terrestrial as opposed to celestial, all terrestrial natures being regarded as admitting of resolution into one or more of the four elements.

[88] '*Lux*, id quod *lumine* diffunditur, claritas, fulgor; *Lumen*, id quod splendorem diffundit.' Döderlein, ii. 66, as quoted by Mr. Kitchin.

[89] Bacon is comparing two disparate phenomena, namely, the heat arising from the *consumption* by fire of spirits of wine with the heat arising from iron, when merely rendered red-hot. If we compare the heat evolved by the *consumption* of both substances, the advantage is greatly on the side of Spirits of Wine. Taking as thermal unit the heat necessary

8. Per aurum et alia metalla ignita, quae densissimi sunt corporis secundum totum, *rejice* tenuitatem.
9. Per aërem, qui invenitur ut plurimum frigidus, et tamen manet tenuis, *rejice* etiam tenuitatem.
10. Per ferrum ignitum, quod non intumescit mole [90], sed manet intra eandem dimensionem visibilem, *rejice* motum localem aut expansivum secundum totum.
11. Per dilatationem aëris in vitris calendariis et similibus, qui movetur localiter et expansive manifesto, neque tamen colligit manifestum augmentum caloris [91], *rejice* etiam motum localem aut expansivum secundum totum.
12. Per facilem tepefactionem omnium corporum, absque aliqua destructione aut alteratione notabili, *rejice* naturam destructivam aut inditionem violentam alicujus naturae novae.
13. Per consensum et conformitatem operum similium quae eduntur a calore et a frigore, *rejice* motum tam expansivum quam contractivum secundum totum.
14. Per accensionem caloris ex attritione corporum, *rejice* naturam principialem [92]. Naturam principialem vo-

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to raise the temperature of a pound of water through *one* degree Centigrade, the thermal units in round numbers disengaged by a pound of Absolute Alcohol and a pound of Iron are respectively 7180 and 1576. See Ganot's Physics, Translation, 6th Ed., § 448.

[90] This statement is, of course, erroneous. But see notes on Aph. 24.

[91] The sole cause of the expansion of the air is its increase in temperature, though, in so small a quantity of air as is contained in a thermometer, the increased temperature is not sensible to the touch. It is the more curious that Bacon should have fallen into this error, when we compare what he says at the beginning of Inst. 38 of Aph. 13.

'Secundum totum' here and elsewhere is, of course, opposed to 'per particulas.' It is, perhaps, hardly necessary to notice the perverse interpretation of this expression by Liebig as 'on the whole;' as if Bacon meant that in the majority of cases, but not in all, expansion enters into the 'form of heat.' See Liebig's answer to Sigwart in the Allgemeine Zeitung (Tchihatchef, p. 159). What Bacon obviously refers to is the motion of the entire body, as distinct from that of the minute particles. Cp. Aph. 20, Tertia Differentia.

[92] Such would be the so-called substance of caloric, which was long supposed to be contained in bodies, and to be the cause of heat. The existence of this supposed substance was disproved by Rumford and Davy. See Tyndall's Heat a Mode of Motion, §§ 20–23, and Appendix ii. to

camus eam, quae positiva reperitur in natura, nec causatur a natura praecedente.

Sunt et aliae naturae: neque enim tabulas conficimus perfectas, sed exempla tantum.

Omnes et singulae naturae praedictae non sunt ex forma calidi. Atque ab omnibus naturis praedictis liberatur homo in operatione super calidum.

XIX.

Atque in *exclusiva* jacta sunt fundamenta *inductionis* verae, quae tamen non perficitur donec sistatur in affirmativa. Neque vero ipsa *exclusiva* ullo modo perfecta est, neque adeo esse potest sub initiis. Est enim *exclusiva* (ut plane liquet) *rejectio* naturarum simplicium[93]. Quod si non habeamus adhuc bonas et veras notiones[94] naturarum simplicium, quomodo rectificari potest *exclusiva?* At nonnullae ex supradictis (veluti notio naturae elementaris, notio naturae coelestis, notio tenuitatis) sunt notiones vagae, nec bene terminatae. Itaque nos, qui nec ignari sumus nec obliti quantum opus aggrediamur (viz. ut faciamus intellectum

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chap. ii. Both Bacon and Locke, however, had already anticipated what is now called the dynamical or mechanical theory of heat.

'Bacon here anticipates not merely the essential character of the most recent theory of heat, but also the kind of evidence by which it has been established. The proof that caloric does not exist,—in other words that heat is not the manifestation of a peculiar substance diffused through nature,—rests mainly on experiments of friction.' Mr. Ellis' note.

[93] As opposed to concrete bodies, the forms of which are 'formae copulatae.'

[94] But these are themselves to be gained by Induction. See Bk. i. Aphs. 14, 18, 40. The fact is that true axioms and sound notions are interdependent and imply each other. In Mathematics, the work of definition is elementary and comparatively easy, but in the Physical and Moral Sciences, we must already have made considerable advances, before we can begin to define with any precision. Cp. note 99 on i. 59. Our notions become clearer as we ascertain more facts, and, as our notions become clearer, the facts we collect or infer become more pertinent and more pregnant. Hence, I am inclined to think that Bacon did not contemplate two distinct kinds of induction, one for the clearing up of conceptions and another for the establishment of axioms. Mr. Ellis, however (see General Preface, vol. i. p. 37), is apparently of a different opinion.

humanum rebus et naturae parem), nullo modo acquiescimus in his, quae adhuc praecepimus: sed et rem in ulterius provehimus, et fortiora auxilia in usum intellectus machinamur et ministramus; quae nunc subjungemus. Et certe in *interpretatione naturae* animus omnino taliter est praeparandus et formandus, ut et sustineat se in gradibus debitis certitudinis, et tamen cogitet (praesertim sub initiis) ea quae adsunt multum pendere ex iis quae supersunt.

XX.

Attamen quia citius emergit veritas ex errore quam ex confusione, utile putamus, ut fiat permissio intellectui [95], post

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[95] Here Bacon advocates the employment of hypothesis, notwithstanding his implied condemnation of it in the First Book. See i. 19, and my note upon it. His remark at the beginning of the present Aphorism is conceived in a far truer and more scientific spirit than the language which (unless we except that of i. 106, q.v.) he has hitherto employed on the subject. To repeat what I have said elsewhere: 'Even though a hypothesis may ultimately be discovered to be false, it may be of great service in pointing the way to a truer theory. Thus the circular theory of planetary motion, and the supplementary theory of epicycles and eccentrics, undoubtedly contributed to the formation of the hypothesis which was eventually proved to be true. Kepler himself tried no less than nineteen different hypotheses, before he hit upon the right one, and his ultimate success was doubtless in no slight degree due to his unsuccessful efforts. There is hardly any branch of science in which it might not be affirmed that, without a number of false guesses, true theories could never have been attained.' Inductive Logic, 3rd Ed., p. 98.

Mr. Ellis (in his General Preface, vol. i. pp. 36, 37) makes the following important remarks on the relation of this Aphorism to the others of the Second Book: 'The phrase Permissio Intellectus sufficiently indicates that in this process the mind is suffered to follow the course most natural to it; it is relieved from the restraints hitherto imposed on it, and reverts to its usual state. In this Vindemiatio we accordingly find no reference to the method of exclusion: it rests immediately on the three tables of Comparentia; and though of course it does not contradict the results of the Exclusiva, yet on the other hand it is not derived from them. If we lose sight of the real nature of this part of the investigation, which is merely introduced by the way "because truth is more easily extricated from error than from confusion," we also lose sight of the scope and purport of the whole method. All that Bacon proposes henceforth to do is to perfect the Exclusiva; the Vindemiatio prima, though it is the closing member of the example which Bacon makes use of, is not to be taken as the type of the final conclusion of any investigation which he would

tres tabulas *comparentiae primae* (quales posuimus) factas et pensitatas, accingendi se et tentandi opus *interpretationis naturae* in affirmativa; tam ex instantiis tabularum, quam ex iis quae alias occurrent. Quod genus tentamenti, *permissionem intellectus*, sive *interpretationem inchoatam*, sive *vindemiationem primam* appellare consuevimus.

Vindemiatio prima de forma calidi.

Animadvertendum autem est, formam rei inesse (ut ex iis quae dicta sunt plane liquet) instantiis universis et singulis, in quibus res ipsa inest [96]; aliter enim forma non esset: itaque nulla plane dari potest *instantia* contradictoria. Attamen longe magis conspicua invenitur forma et evidens in aliquibus *instantiis*, quam in aliis; in iis videlicet, ubi minus cohibita est natura formae et impedita et redacta in ordinem per naturas alias. Hujusmodi autem instantias, *elucescentias* vel *instantias ostensivas* appellare consuevimus [97]. Pergendum itaque est ad *vindemiationem* ipsam *primam* de forma calidi.

> Per universas et singulas *instantias*, natura cujus limitatio est calor videtur esse motus. Hoc autem maxime ostenditur in flamma, quae perpetuo movetur; et in liquoribus ferventibus aut bullientibus, qui etiam perpetuo moventur. Atque ostenditur etiam in incitatione sive incremento caloris facto per motum; ut in follibus [98],

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recognise as just and legitimate. It is only a parenthesis in the general method, whereas the Exclusiva, given in the eighteenth aphorism of the second book, is a type or paradigm of the process on which every true induction (inductio vera) must in all cases depend.'

[96] See notes on Aphs. 16, 17. The argument would have been perfectly correct, not only with reference to 'natures' but also with reference to 'causes,' if he had said that, wherever the supposed form is, there the thing itself must be. Thus, if we start the hypothesis that motion is causally connected with heat, and we find, as a matter of fact, that motion is always attended by an increase of temperature, the hypothesis becomes an ascertained truth. We can, as I have so frequently stated, argue with certainty from the cause to the effect, but not from the effect to the cause.

[97] See Aph. 24.

[98] On this and some of the other instances here alluded to, see notes above. We have now reached a point at which it becomes superfluous to criticise in detail either the instances themselves or the inferences based upon them.

et ventis; de quo vide Instant. 29. Tab. 3. Atque similiter in aliis modis motus, de quibus vide Instant. 28. et 31. Tab. 3. Rursus ostenditur in extinctione ignis et caloris per omnem fortem compressionem, quae fraenat et cessare facit motum; de qua vide Instant. 30. et 32. Tab. 3. Ostenditur etiam in hoc, quod omne corpus destruitur aut saltem insigniter alteratur ab omni igne et calore forti ac vehementi; unde liquido constat, fieri a calore tumultum et perturbationem et motum acrem in partibus internis corporis, qui sensim vergit ad dissolutionem[99].

Intelligatur hoc quod diximus de motu (nempe, ut sit instar generis ad calorem), non quod calor generet motum, aut quod motus generet calorem (licet et haec in aliquibus[1] vera sint), sed quod ipsissimus calor, sive *quid ipsum*[2] caloris, sit motus et nihil aliud; limitatus tamen per *differentias* quas mox subjungemus, postquam nonnullas cautiones adjecerimus ad evitandum aequivocum.

Calidum ad sensum[3] res respectiva est, et in ordine ad hominem non ad universum; et ponitur recte ut effectus caloris tantum in spiritum animalem. Quin etiam in seipso res varia est, cum idem corpus (prout sensus praedisponitur) inducat perceptionem tam calidi quam frigidi; ut patet per Instant. 41. Tab. 3.

Neque vero communicatio caloris, sive natura ejus transitiva per quam corpus admotum corpori calido incalescit, confundi debet cum forma calidi[4]. Aliud enim est calidum,

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[99] This is well and correctly stated, though Bacon did not know what becomes of the parts of the body, on 'dissolution.'

[1] Heat and motion are not only occasionally, but invariably convertible or capable of passing into each other.

[2] τὸ τί ἐστι. Here, of course, form is used unequivocally for 'nature' or 'essence.' Cp. the expressions below: 'differentias veras, quae limitant motum, et constituunt eum in formam calidi;' 'forma sive definitio vera caloris.'

[3] 'Calidum ad sensum' is here opposed to 'calor,' the former being an affection of our organism, the latter an affection of the body itself.

[4] Heat itself is distinct from its production or communication. This is all that Bacon seems to mean.

aliud calefactivum. Nam per motum attritionis inducitur calor absque aliquo calido praecedente, unde excluditur calefactivum a forma calidi. Atque etiam ubi calidum efficitur per approximationem calidi, hoc ipsum non fit ex forma calidi, sed omnino pendet a natura altiore et magis communi; viz. ex natura assimilationis sive multiplicationis sui; de qua facienda est separatim inquisitio[5].

At notio ignis plebeia est, et nihil valet: composita enim est ex concursu qui fit calidi et lucidi in aliquo corpore; ut in flamma communi, et corporibus accensis usque ad ruborem.

Remoto itaque omni aequivoco, veniendum jam tandem est ad *differentias* veras, quae limitant motum et constituunt[6] eum in formam calidi.

> *Prima* igitur *differentia* ea est, quod calor sit motus expansivus[7], per quem corpus nititur ad dilatationem sui, et recipiendi[8] se in majorem sphaeram sive dimensionem quam prius occupaverat. Haec autem *differentia* maxime ostenditur in flamma; ubi fumus sive halitus pinguis manifesto dilatatur et aperit se in flammam.
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> Ostenditur etiam in omni liquore fervente, qui manifesto intumescit, insurgit, et emittit bullas; atque urget processum expandendi se, donec vertatur in corpus longe magis extensum et dilatatum quam sit ipse liquor; viz. in vaporem aut fumum aut aërem[9].

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[5] See Aph. 48, 'Motus undecimus.'

[6] In the language of the scholastic logic, the differentia is said to divide the genus and to constitute the species.

[7] In Aph. 18, Inst. 10, he rejects 'motum expansivum, secundum totum,' and in the third differentia assigned in this Aphorism, he describes heat as 'motus, non expansivus uniformiter secundum totum, sed expansivus per particulas minores corporis.' It is difficult, however, to see how the minute particles of a body could be expanded without causing the expansion of the whole body, especially as Bacon (see Aph. 8) rejected the idea of a vacuum between the particles. As a fact, all bodies (with a few exceptions, such as water between 32° and 39° Fahrenheit, and bismuth at the moment of solidification) expand with an augmentation of temperature.

[8] This, which is the reading of the First Edition, must be a misprint for 'recipiendum,' the reading of the second and most subsequent editions.

[9] Cp. an interesting passage on the conversion of solids into liquids, and

Ostenditur etiam in omni ligno et combustibili; ubi fit aliquando exudatio, at semper evaporatio.

Ostenditur etiam in colliquatione metallorum, quae (cum sint corporis compactissimi) non facile intumescunt et se dilatant; sed tamen spiritus eorum[10], postquam fuerit in se dilatatus, et majorem adeo dilatationem concupierit, trudit plane et agit partes crassiores in liquidum. Quod si etiam calor fortius intendatur, solvit et vertit multum ex iis in volatile.

Ostenditur etiam in ferro aut lapidibus; quae licet non liquefiant aut fundantur, tamen emolliuntur. Quod etiam fit in baculis ligni; quae calefacta paululum in cineribus calidis fiunt flexibilia.

Optime autem cernitur iste motus in aëre, qui per exiguum calorem se dilatat continuo et manifesto; ut per Instant. 38. Tab. 3.

Ostenditur etiam in natura contraria frigidi[11]. Frigus enim omne corpus contrahit[12] et cogit in angustius; adeo ut per intensa frigora clavi excidant ex parietibus, aera dissiliant, vitrum etiam calefactum et subito positum in frigido dissiliat et frangatur. Similiter aër per levem infrigidationem recipit se in angustius; ut per Instant. 38. Tab. 3. Verum de his fusius dicetur in inquisitione de Frigido.

Neque mirum est si calidum et frigidum edant complures actiones communes (de quo vide Instant. 32. Tab. 2), cum inveniantur duae ex sequentibus *differentiis* (de quibus mox dicemus) quae competunt utrique naturae; licet in hac *differentia* (de qua nunc loquimur) actiones sint ex diametro oppositae. Calidum enim dat motum expansivum et dilatantem, Frigidum autem dat motum contractivum et coëuntem.

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of liquids into vapours, in Herschel's Discourse on the Study of Natural Philosophy, §§ 357, 358, and see also note 34 on Aph. 33.

[10] Notice again the curious language which Bacon employs about the 'spirits' of inanimate objects. Cp. i. 50, ii. 7, ii. 40, &c.

[11] Here again we have the conception of cold as a positive quality.

[12] This is not universally true. See note 7 above. Water-pipes, for instance, are often burst by the expansion of ice at the moment of solidification.

Secunda differentia est modificatio prioris; haec videlicet, quod calor sit motus expansivus sive versus circumferentiam; hac lege tamen, ut una feratur corpus sursum[13]. Dubium enim non est quin sint motus complures mixti. Exempli gratia; sagitta aut spiculum simul et progrediendo rotat, et rotando progreditur. Similiter et motus caloris simul est et expansivus et latio in sursum.

Haec vero *differentia* ostenditur in forcipe, aut bacillo ferreo immisso in ignem: quia si immittatur perpendiculariter tenendo manum superius, cito manum adurit; sin ex latere aut inferius, omnino tardius.

Conspicua etiam est in distillationibus per descensorium; quibus utuntur homines ad flores delicatiores, quorum odores facile evanescunt. Nam hoc reperit industria, ut collocent ignem non subter sed supra, ut adurat minus[14]. Neque enim flamma tantum vergit sursum, sed etiam omne calidum.

Fiat autem experimentum hujus rei in contraria natura frigidi: viz. utrum frigus non contrahat corpus descendendo deorsum, quemadmodum calidum dilatat corpus ascendendo sursum. Itaque adhibeantur duo bacilla ferrea, vel duo tubi vitrei, quoad caetera pares, et calefiant nonnihil; et ponatur spongia cum aqua frigida, vel nix, subter unam, et similiter super alteram. Existimamus

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[13] In gases and liquids, the heated particles, being expanded, and so occupying more space in proportion to their density, ascend, while the particles not yet equally heated remain stationary, or descend. This mode of diffusion of heat is called Convection. See Tyndall's Heat a Mode of Motion, §§ 221, 222. There is, of course, no analogous phenomenon in the case of solids. Bacon's example of 'the tongs and poker' is purely fanciful, the idea having probably arisen from the fact that, in order to make them stand upright, they must be planted more firmly in the fire, and so exposed to a larger amount of heat, than when placed horizontally. Moreover, the heat radiated from the fire upwards in the direction of the chimney is usually much greater than that radiated sideways.

It will be seen from what is here said, that this second differentiation is delusive.

[14] Heat being propagated in liquids both by convection and conduction, and more in the former way than the latter, it will be plain from the last note that it ascends in them more quickly than it descends. Hence, a liquid will be warmed more slowly by a fire above than by a fire below.

enim celeriorem fore refrigerationem ad extremitates in eo bacillo ubi nix ponitur supra quam in eo ubi nix ponitur subter: contra ac fit in calido.

Tertia differentia ea est; ut calor sit motus, non expansivus uniformiter[15] secundum totum, sed expansivus per particulas minores corporis; et simul cohibitus et repulsus et reverberatus, adeo ut induat motum alternativum[16] et perpetuo trepidantem et tentantem et nitentem et ex repercussione irritatum; unde furor ille ignis et caloris ortum habet.

Ista vero *differentia* ostenditur maxime in flamma et liquoribus bullientibus; quae perpetuo trepidant, et in parvis portionibus tument, et rursus subsidunt.

Ostenditur etiam in iis corporibus, quae sunt tam durae compagis ut calefacta aut ignita non intumescant aut dilatentur mole; ut ferrum ignitum[17], in quo calor est acerrimus.

Ostenditur etiam in hoc, quod per frigidissimas tempestates focus ardeat acerrime[18].

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[15] That is to say, some particles are heated before others, and, consequently, the whole mass is, at any given time, heated unequally in its different parts. This circumstance does not, however, prevent the expansion of the body as a whole, which must be a necessary consequence of the expansion of even a portion of its constituent particles. See note 7 above.

[16] This description seems to be a remarkable anticipation of the Undulatory Theory of Heat. Cp. Tyndall, Heat a Mode of Motion, § 339: 'Let us now revert for a moment to our fundamental conceptions regarding radiant heat. Its origin is an oscillatory motion of the ultimate particles of matter—a motion taken up by the ether, and propagated through it in waves. The particles of ether in these waves do not oscillate in the same manner as the particles of air, in the case of sound. The air-particles move to and fro, in the direction in which the sound travels; the ether particles move to and fro, *across* the line in which the light travels. The undulations of the air are longitudinal, those of the ether transversal. The ether waves resemble more the ripples of water than they do the aërial pulses which produce sound.'

[17] See note on Aph. 18, Inst. 10.

[18] See note on Aph. 13, Inst. 36.

Bacon's theories are in advance of his proofs. Most of the instances collected under this 'Third Differentia' are of little, if any, value towards proving the conclusion.

Ostenditur etiam in hoc, quod cum extenditur aër in vitro calendari absque impedimento aut repulsione, uniformiter scilicet et aequaliter, non percipiatur calor. Etiam in ventis conclusis, licet erumpant vi maxima, tamen non percipitur calor insignis; quia scilicet motus fit secundum totum, absque motu alternante in particulis. Atque ad hoc fiat experimentum, utrum flamma non urat acrius versus latera quam in medio flammae.

Ostenditur etiam in hoc, quod omnis ustio transigatur per minutos poros corporis quod uritur; adeo ut ustio subruat et penetret et fodicet et stimulet, perinde ac si essent infinitae cuspides acus. Itaque ex hoc illud etiam fit, quod omnes aquae fortes (si proportionatae sint ad corpus in quod agunt) edant opera ignis, ex natura sua corrodente et pungente.

Atque ista *differentia* (de qua nunc dicimus) communis est cum natura frigidi; in quo cohibetur motus contractivus per renitentiam expandendi; quemadmodum in calido cohibetur motus expansivus per renitentiam contrahendi.

Itaque sive partes corporis penetrent versus interius sive penetrent versus exterius, similis est ratio; licet impar admodum sit fortitudo; quia non habemus hic apud nos in superficie terrae aliquid quod sit impense frigidum. Vide Instant. 27. Tab. 9.

Quarta differentia est modificatio prioris: haec scilicet, quod motus ille stimulationis aut penetrationis debeat esse nonnihil rapidus et minime lentus; atque fiat etiam per particulas, licet minutas; tamen non ad extremam subtilitatem, sed quasi majusculas[19].

Ostenditur haec *differentia* in comparatione operum quae edit ignis cum iis quae edit tempus sive aetas. Aetas enim sive tempus arefacit, consumit, subruit, et incinerat, non minus quam ignis; vel potius longe

[19] This last qualification is, of course, erroneous, and seems to have been suggested by the fanciful contrast, drawn below, between time and fire. Heat is a motion of the *ultimate* particles of matter, whatever those may be.

subtilius: sed quia motus ejusmodi est lentus admodum et per particulas valde exiles, non percipitur calor.

Ostenditur etiam in comparatione dissolutionum ferri et auri[20]. Aurum enim dissolvitur absque calore excitato; ferrum autem cum vehementi excitatione caloris, licet simili fere intervallo quoad tempus. Quia scilicet in auro, ingressus aquae separationis est clemens et subtiliter insinuans, et cessio partium auri facilis; at in ferro, ingressus est asper et cum conflictu, et partes ferri habent obstinationem majorem.

Ostenditur etiam aliquatenus in gangraenis nonnullis et mortificationibus carnium; quae non excitant magnum calorem aut dolorem, ob subtilitatem putrefactionis.

Atque haec sit *Prima Vindemiatio*, sive *Interpretatio inchoata* de Forma Calidi, facta per *Permissionem Intellectus.*

Ex *Vindemiatione* autem ista *Prima*, forma sive definitio vera[21] caloris (ejus qui est in ordine ad universum, non relativus tantummodo ad sensum) talis est, brevi verborum complexu: *Calor est motus expansivus, cohibitus, et nitens per partes minores.* Modificatur autem expansio: *ut expandendo in ambitum*[22], *nonnihil tamen inclinet versus superiora*[23]. Modificatur autem et nixus ille per partes; *ut non sit omnino segnis, sed incitatus et cum impetu nonnullo.*

Quod vero ad Operativam attinet, eadem res est. Nam designatio est talis: *Si in aliquo corpore naturali poteris excitare motum ad se dilatandum aut expandendum; cumque motum ita reprimere et in se vertere, ut dilatatio illa non procedat aequaliter, sed partim obtineat, partim retrudatur; proculdubio generabis calidum:* non habita ratione, sive corpus illud sit elementare (ut loquuntur), sive imbutum a coelestibus[24]; sive

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[20] He is here alluding to the instances given under Aphs. 11 (19) and 12 (25), relating to the chemical dissolution of iron and gold respectively.

[21] Notice that 'form' is here identified with definition.

[22] All round, in all directions.

[23] See note 13 above.

[24] Spectrum analysis has recently shown that 'celestial' and 'terrestrial' or 'elementary' bodies are of much the same chemical composition. The common opinion in Bacon's time, inherited from the Peripatetics (see De

luminosum, sive opacum; sive tenue, sive densum; sive localiter expansum, sive intra claustra dimensionis primae contentum; sive vergens ad dissolutionem, sive manens in statu; sive animal, sive vegetabile, sive minerale, sive aqua, sive oleum, sive aër, aut aliqua alia substantia quaecunque susceptiva motus praedicti. Calidum autem ad sensum res eadem est; sed cum analogia [25], qualis competit sensui. Nunc vero ad ulteriora auxilia procedendum est [26].

XXI.

Post *Tabulas comparentiae primae* et *rejectionem* sive *exclusivam*, nec non *vindemiationem primam* factam secundum eas, pergendum est ad reliqua auxilia intellectus circa *interpretationem naturae* et *inductionem* veram ac perfectam. In quibus proponendis, ubi opus erit tabulis, procedemus super calidum et frigidum; ubi autem opus erit tantum exemplis paucioribus, procedemus per alia omnia: ut nec confundatur inquisitio, et tamen doctrina versetur minus in angusto.

Coelo, i. 3, ii. 7, and other places), was that the heavenly bodies are composed of an entirely different substance (a fifth essence, or element) from those which enter into the composition of sublunary bodies. Bacon, while opposing this opinion, admits that there is no doubt 'quin regiones sub luna positae et supra, una cum corporibus quae sub iisdem spatiis continentur, multis et magnis rebus differant.' See Descriptio Globi Intellectualis, cap. 7 (E. and S., vol. iii. p. 748, &c.).

On the expression '*imbutum* a coelestibus,' cp. what Bacon says on Astrology in De Augmentis, iii. 4 (E. and S., vol. i. pp. 554–60).

[25] By this explanation he means that the 'calidum ad sensum' is simply the 'calidum in se' in its *relation* to our senses. 'Calor,' as perceived by us, is modified by the condition of the percipient.

[26] Mr. Ellis (pp. 266, 267) has an interesting note on various points connected with the 'Inquisitio de forma calidi.' It is too long to quote, but the student may refer to it with advantage, bearing in mind, however, that the dynamical theory of heat has gained considerably in evidence since the time at which Mr. Ellis wrote. Most of the points touched on in this note have been mentioned by me in the course of my own annotations.

The 'ulteriora auxilia' are designed for the purpose of perfecting the 'Exclusiva,' for which purpose the Tables alone are not supposed to be sufficient. The necessary imperfection of his method, in the present state of knowledge, and with the present modes of enquiry, is acknowledged by Bacon himself in Aph. 19.

To the parenthetical character of the Aphorism just concluded I have already drawn attention in the extracts from Mr. Ellis' General Preface in note 95 above.

Dicemus itaque primo loco, de *Praerogativis Instantiarum*[27]: secundo[28], de *Adminiculis Inductionis*: tertio, de *Rectificatione*

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[27] So called from the 'Tribus Praerogativa' which, being selected by lot, voted first in the 'Comitia Tributa' of the Romans, and thus afforded an indication of the mode in which the other tribes were likely to vote. Its vote also frequently exercised a considerable influence on the succeeding votes.

'By the prerogatives of instances,' says Sir John Herschel (Discourse on the Study of Natural Philosophy, § 190), 'Bacon understands characteristic phenomena, selected from the great miscellaneous mass of facts which occur in nature, and which, by their number, indistinctness, and complication, tend rather to confuse than to direct the mind in its search for causes and general heads of induction. Phenomena so selected on account of some peculiarly forcible way in which they strike the reason, and impress us with a kind of sense of causation, or a particular aptitude for generalisation, he considers, and justly, as holding a kind of prerogative dignity, and claiming our first and especial attention in physical enquiries.'

On the more important of these 'praerogativae instantiarum' some excellent remarks and illustrations will be found in Herschel's Discourse, &c., §§ 190–200, Playfair's Preliminary Dissertation to the Encyclopaedia Britannica, Section 2, and Dr. Hippus' Account of the Novum Organum, Part ii, in the Library of Useful Knowledge (which, however, borrows largely from Playfair's Dissertation). From these sources, I shall, as we proceed, extract what appears to me most valuable.

In the 'General Preface to the Philosophical Works,' Mr. Ellis remarks that 'to the word *instance* Bacon gives a wide range of signification. It corresponds more nearly to *observation* than to any other term which is used in modern scientific language.'

[28] Cp. the passage at the end of the book: 'Nunc vero ad *adminicula* et *rectificationes inductionis*, et deinceps ad *concreta*, et *latentes processus*, et *latentes schematismos*, et reliqua, quae aphorismo 21. ordine proposuimus, pergendum.' In this passage 'ad concreta' seems to answer to the 'Variatio Inquisitionis pro Natura Subjecti' of the text, and, perhaps, 'Latentes Processus et Latentes Schematismi' to the 'Deductio ad Praxin,' though M. Bouillet refers these also to the Variatio Inquisitionis.

Mr. Ellis (General Preface, p. 43) observes that the practical utility of the prerogative instances would have been explained when Bacon came to speak of the Adminicula Inductionis. M. Bouillet, on the other hand, thinks that the 'Adminicula Inductionis' were to embrace the 'Ministratio ad Sensum' and 'Ministratio ad Memoriam,' mentioned in Aph. 10. He refers to the conclusion of Aphs. 42 and 43, and quotes from the Partis Secundae Delineatio the words 'ministratio ad rationem cui ministrationes duae priores subministrant.' See E. and S., vol. iii. p. 553.

In M. Bouillet's note on this Aphorism, there is an attempt to determine the exact character of these missing parts of the Novum Organum, and, where possible, to supply them from other portions of Bacon's works.

Inductionis: quarto, de *Variatione Inquisitionis pro Natura Subjecti:* quinto[29], de *Praerogativis Naturarum* quatenus ad inquisitionem, sive de eo quod inquirendum est prius et posterius: sexto, de *Terminis Inquisitionis*, sive de synopsi omnium naturarum in universo: septimo, de *Deductione ad Praxin*, sive de eo quod est in ordine ad Hominem: octavo[30], de *Parascevis ad Inquisitionem:* postremo autem, de *Scala Ascensoria et Descensoria Axiomatum.*

XXII.

Inter *Praerogativas Instantiarum*[31], primo proponemus

The attempt is interesting and ingenious, but it is too conjectural, as well as too lengthy, to admit of being reproduced here. The reader, however, would do well to compare with this Aphorism the Partis Secundae Delineatio (E. and S., vol. iii. pp. 547-57).

[29] He seems here to contemplate the arrangement of the simple natures, or, at least, the principal ones, in a kind of hierarchy, according to their relative importance, as in the sixth division he designs an exhaustive enumeration of them.

[30] Towards this division we have a contribution in the tract printed at the end of the first edition of the Novum Organum, entitled 'Parasceue,' &c. Bacon expressly says in the Introduction to it: 'Huic autem rei locus proprius foret quum ad *Parasceuas* Inquisitionis ordine deventum fuerit. Hoc vero praevertere, nec locum proprium expectare, consultius nobis videtur.'

[31] In Aph. 52, these Praerogativae Instantiarum are divided into such as are concerned 'circa partem informativam' (1-20, of which 1-15 'juvant intellectum,' 16-20 'juvant sensum'), and such as are concerned 'circa partem operativam' (21-27). For further subdivisions, see the Aphorism itself.

This portion of the Novum Organum, it must be confessed, is defective in arrangement, nor does it supply any systematic set of rules for the investigation of nature. It consists rather of a miscellaneous collection of remarks, hints, and directions, many of which are exceedingly valuable and suggestive, though often expressed in fanciful language and often illustrated by examples which we should now deem worthless and unscientific. Of Bacon's terminology, however, I may remark that it has at least been so felicitously selected, as in many cases to have left a permanent mark on the language, as, for example, in the expressions 'Crucial Instance,' 'Glaring Instance,' 'Clandestine Instance,' and the like.

In the Partis Secundae Delineatio (E. and S., vol. iii. p. 556), the Praerogativa Instantiae together with the Praerogativa Inquisiti are described as constituting the 'inquisitionis contractio,' which has for its office 'ut non tantum in inviis via, sed in viis compendium, et tanquam linea recta

Instantias Solitarias[32]. Eae autem sunt *solitariae*, quae exhibent naturam de qua fit inquisitio in talibus subjectis, quae nil habent commune cum aliis subjectis, praeter illam ipsam naturam; aut rursus quae non exhibent naturam de qua fit inquisitio in talibus subjectis, quae sunt similia per omnia cum aliis subjectis, praeterquam in illa ipsa natura. Manifestum enim est quod hujusmodi instantiae tollant ambages, atque accelerent et roborent *exclusivam*[33]; adeo ut paucae ex illis sint instar multarum.

Exempli gratia: si fiat inquisitio de natura *Coloris*[34], *Instantiae Solitariae* sunt prismata, gemmae chrystallinae, quae reddunt colores non solum in se sed exterius supra parietem,

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quae per ambages et flexus secet, ex indiciis nostris innotescat.' 'Itaque docebimus primo,' he goes on to say, 'quales sint illae instantiae, sive experimenta, quae ad illuminationem prae caeteris excellant, adeo ut paucae idem quod aliae plures praestent. Hoc enim et moli ipsius historiae, et discurrendi laboribus parcit.'

[32] Bacon could hardly have commenced with a more promising example of his 'prerogatives.' It is curious that the two divisions of the 'instantiae solitariae' correspond respectively with Mill's Methods of Agreement and Difference. To quote what I have said elsewhere (Inductive Logic, 3rd Ed., p. 146): 'In the Method of Difference, the instances agree in everything, except in the possession of two circumstances which are present in the one instance and absent in the other. In the Method of Agreement, the various instances compared (for here we generally require more than two instances) agree in nothing, except in the possession of two circumstances which are common to all the instances.' Here, of course, the 'two circumstances' are the 'natura de qua fit inquisitio' and the assigned cause. The cogency of these methods is almost evident from the statement of them. 'The Method of Agreement,' says Mr. Mill, 'stands on the ground that whatever can be eliminated, is not connected with the phenomenon by any law. The Method of Difference has for its foundation that whatever can *not* be eliminated, *is* connected with the phenomenon by a law.'

[33] The second division, answering to the Method of Difference, does more than this. If its conditions were perfectly satisfied, it would demonstrate the truth of the assigned cause.

[34] Bacon is no less happy in his example than in his rule. 'He concludes,' says Professor Playfair, 'that colour is nothing else than a modification of the rays of light, produced, in the first case, by the different degrees of incidence; and, in the second, by the texture or constitution of the surfaces of bodies. He may be considered as very fortunate in fixing on these examples; for it was by means of them that Newton afterwards found out the composition of light.'

item rores, &c. Istae enim nil habent commune cum coloribus fixis in floribus, gemmis coloratis, metallis, lignis, &c., praeter ipsum colorem. Unde facile colligitur, quod color nil aliud sit quam modificatio imaginis lucis immissae et receptae: in priore genere, per gradus diversos incidentiae; in posteriore, per texturas et schematismos varios corporis. Istae autem *Instantiae* sunt *Solitariae* quatenus ad similitudinem[35].

Rursus in eadem inquisitione, venae distinctae albi et nigri in marmoribus, et variegationes colorum in floribus ejusdem speciei, sunt *Instantiae Solitariae.* Album enim et nigrum marmoris, et maculae albi et purpurei in floribus garyophylli[36], conveniunt fere in omnibus praeter ipsum colorem. Unde facile colligitur, colorem non multum rei habere cum naturis alicujus corporis intrinsecis, sed tantum situm esse in positura partium crassiori et quasi mechanica. Istae autem *Instantiae* sunt *Solitariae*, quatenus ad discrepantiam. Utrunque autem genus *Instantias Solitarias* appellare consuevimus; aut *Ferinas*[37], sumpto vocabulo ab astronomis.

XXIII.

Inter praerogativas instantiarum, ponemus secundo loco *Instantias Migrantes*[38]. Eae sunt, in quibus natura inquisita

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[35] It will be noticed that the very expressions 'Method of Agreement' and 'Method of Difference' all but occur in the Text.

[36] More properly Caryophilli, from καρυόφυλλον. The name, with Bacon, probably designates pinks, carnations, and cloves.

[37] Mr. Kitchin gives up this word in despair. I have little doubt that Mr. Ellis is right in his conjecture that it is used (possibly by an accidental substitution) for *feralis*, which is thus defined in the Lexicon Mathematicum of Hieronymus Vitalis, published at Paris in 1668: 'Feralis, [S.C.] apud Astronomos dicitur planeta, quando fuerit in loco, ubi nullam cum reliquis familiaritatem habet: quod quidem maximum est detrimentum, et potissime attenditur in Luna, quae proinde in eo casu appellatur Agrestis, cursu vacua,' &c.

[38] Cp. the Tabula Graduum of Aph. 13, and Mill's Method of Concomitant Variations.

'Bacon's "travelling instances" are those in which the *nature* or quality under investigation "travels," or varies in degree; thus affording an indication of a cause by a gradation of intensity in the effect. One of his instances is very happy, being that of 'paper, which is white when dry, but proves less so when wet, and comes nearer to the state of

migrat ad generationem, cum prius non existeret; aut contra migrat ad corruptionem, cum prius existeret. Itaque in utraque antistrophe, instantiae tales sunt semper geminae [39]; vel potius una instantia in motu sive transitu, producta ad periodum adversam. At hujusmodi instantiae non solum accelerant et roborant *exclusivam*, sed etiam compellunt *affirmativam* sive *formam* ipsam in angustum. Necesse est enim ut forma rei sit quippiam, quod per hujusmodi *migrationem* indatur, aut contra per hujusmodi *migrationem* tollatur et destruatur. Atque licet omnis exclusio promoveat *affirmativam*, tamen hoc magis directe fit in subjecto eodem quam in diversis. Forma autem (ut ex omnibus quae dicta sunt manifesto liquet) prodens se in uno ducit ad omnia. Quo autem simplicior fuerit *migratio*, eo magis habenda est instantia in pretio. Praeterea *Instantiae Migrantes* magni sunt usus ad partem operativam; quia cum proponant formam copulatam cum efficiente aut privante, perspicue designant praxin

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transparency upon the exclusion of the air, and admission of water. In reading this, and many other instances in the Novum Organum, one would almost suppose (had it been written) that its author had taken them from Newton's Optics.

'The travelling instances, as well as what Bacon terms "frontier instances," are cases in which we are enabled to trace that general law which seems to pervade all nature—the law, as it is termed, of continuity, which is expressed in the well-known sentence, "Natura non agit per saltum."' Herschel, §§ 198, 199.

Professor Playfair remarks: 'The mineral kingdom is the great theatre of the *instantiae migrantes*, where the same *nature* is seen in all gradations, from the most perfect state, till it become entirely evanescent. Such are the shells which we see so perfect in figure and structure in limestone, and gradually losing themselves in the finer marbles, till they can no longer be distinguished. The use, also, of one such fact to explain or interpret another, is nowhere so well seen as in the history of the mineral kingdom.'

It may be added, however, that the application of this method to comparative anatomy, to physiology, and to the comparative study of law, morals, politics, art, &c., is, at least, as interesting and instructive as its application to mineralogy. See my Inductive Logic under the head of 'Method of Concomitant Variations.'

At the instant when the phenomenon is actually generated, or actually vanishes, the instance falls under the Method of Difference. See note 46 below.

[39] That is, as one quality is making its appearance, the other is vanishing; thus, as transparency vanishes, whiteness appears, and vice versa.

in aliquibus; unde facilis etiam est transitus ad proxima. Subest tamen in illis nonnihil periculi, quod indiget cautione; hoc videlicet, ne formam nimis retrahant ad efficientem[40], et intellectum perfundant vel saltem perstringant falsa opinione de forma ex intuitu efficientis. Efficiens vero semper ponitur nil aliud esse quam vehiculum sive deferens formae. Verum huic rei, per *exclusivam* legitime factam, facile adhibetur remedium[41].

Proponendum itaque est jam exemplum *instantiae migrantis.* Sit natura inquisita Candor sive Albedo: *instantia migrans* ad generationem est vitrum integrum et vitrum pulverizatum. Similiter, aqua simplex et aqua agitata in spumam. Vitrum enim integrum et aqua simplex diaphana sunt, non alba; at vitrum pulverizatum et aqua in spuma, alba, non diaphana. Itaque quaerendum quid acciderit ex ista *migratione* vitro aut aquae[42]. Manifestum enim est formam albedinis deferri et invehi per istam contusionem vitri et agitationem aquae. Nihil autem reperitur accessisse, praeter comminutionem partium vitri et aquae, et aëris insertionem. Neque vero parum profectum est ad inveniendam formam albedinis, quod corpora duo per se diaphana, sed secundum magis et minus (aër scilicet et aqua, aut aër et vitrum), simul posita per minutas portiones exhibeant albedinem, per refractionem inaequalem radiorum lucis[43].

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[40] Here Bacon expressly distinguishes between the form and the efficient cause. The efficient conveys the form, or superinduces it on any given material, but is not to be confounded with it.

[41] The effect (the 'form' or 'nature') will often be found, where the efficient cause has ceased to operate. Hence, by the Method of Exclusion, the form and its efficient may be distinguished. Thus, long after we have ceased to apply friction, a body may remain heated beyond its ordinary temperature.

[42] This phenomenon arises from the great number of reflecting surfaces which cause a very much larger proportion of light to be reflected or scattered than transmitted. Another good instance of the phenomenon is to be seen in the globules of turpentine, when mixed with water and shaken in a bottle.

[43] It is not to the unequal refraction of the rays of light in the air and water, or air and glass, as the case may be, but to the repeated reflection from so many surfaces, as pointed out in the last note, that the phenomenon of whiteness is due. This reflection, of course, could not take place, unless the particles were mixed with air. It may be

Verum hac in re proponendum est etiam exemplum periculi et cautionis, de quibus diximus. Nimirum facile hic occurret intellectui ab hujusmodi efficientibus depravato, quod ad formam albedinis aër semper requiratur, aut quod albedo generetur tantum per corpora diaphana; quae omnino falsa sunt, et per multas exclusiones convicta [44]. Quin potius apparebit (misso aëre et hujusmodi) corpora omnino aequalia (secundum portiones opticas) dare diaphanum; corpora vero inaequalia per texturam simplicem, dare album; corpora inaequalia secundum texturam compositam, sed ordinatam, dare reliquos colores, praeter nigrum; corpora vero inaequalia per texturam compositam, sed omnino inordinatam et confusam, dare nigrum [45]. Itaque de *instantia migrante* ad generationem

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worth adding that Bacon notices the phenomena of Refraction, properly so called, in Sylva Sylvarum, Exps. 761, 762.

[44] In this passage, Bacon seems explicitly to recognise what we call the Plurality of Causes, namely, the fact that an event may be due to various causes or distinct sets of conditions. An argument might hence be deduced in favour of the position that by Form he invariably intends to express nature or essence rather than cause. As I have stated, however, in the Introduction, I believe that the word is employed by him in various shades of meaning in different places. Should it be said that the form is the set of conditions *immediately* preceding the phenomenon, as it appears to us, and that this is *invariably* the same, it must be borne in mind that, even if we granted this to be the case, the difficulty connected with Plurality of Causes would recur with regard to the set of conditions immediately preceding this, or the set immediately preceding that, and so on; so that it would only be postponed, not eliminated.

[45] This explanation of the colour of bodies is mere guess-work. We have no sufficient evidence, at least as yet, for determining the conditions on which the absorption of colours by various bodies depends. In Newton's Optics, bk. ii. pt. iii, there is a curious and interesting attempt to determine the same problem. Thus, for instance, Newton thinks that 'The Bigness of the Component Parts of Natural Bodies may be conjectured by their colours;' that 'for the production of Black, the corpuscles must be less than any of those which exhibit colours;' and that 'microscopes may at length be improved to the discovery of the particles of bodies on which their colours depend, if they are not already in some measure arrived to that degree of perfection.'

There is a long passage on the theory of Colours in Valerius Terminus (E. and S., vol. iii. p. 236, &c.). Notwithstanding much that is crude in Bacon's speculations, we have only to compare them with such a book as Telesius de Coloribus, to see on how much firmer ground the physicists of his age were treading than those of the previous generation.

in natura inquisita albedinis, propositum est jam exemplum. *Instantia* autem *migrans* ad corruptionem in eadem natura albedinis, est spuma dissoluta, aut nix dissoluta. Exuit enim albedinem et induit diaphanum aqua, postquam fit integrale sine aëre.

Neque vero illud ullo modo praetermittendum est, quod sub *Instantiis Migrantibus* comprehendi debeant non tantum illae quae *migrant* ad generationem et privationem [46], sed etiam illae quae migrant ad majorationem et minorationem; cum illae etiam tendant ad inveniendam formam, ut per definitionem formae superius factam et *tabulam graduum* manifesto liquet. Itaque papyrus, quae sicca cum fuerit alba est, at madefacta (excluso aëre et recepta aqua) minus alba est et magis vergit ad diaphanum, similem habet rationem cum instantiis supradictis.

XXIV.

Inter praerogativas instantiarum, tertio loco ponemus *Instantias Ostensivas*, de quibus in *vindemiatione prima de Calido* mentionem fecimus; quas etiam *Elucescentias* [47], sive *Instantias Liberatas et Praedominantes*, appellare consuevimus. Eae sunt, quae ostendunt naturam inquisitam nudam et substantivam, atque etiam in exaltatione sua aut summo gradu potentiae suae; emancipatam scilicet, et liberatam ab impedimentis, vel saltem per fortitudinem suae virtutis dominantem super ipsa, eaque supprimentem et coercentem. Cum enim omne corpus suscipiat multas naturarum formas copulatas [48] et

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[46] I have drawn attention above (n. 38) to the correspondence between this 'Prerogative' and the Method of Concomitant Variations. But, strictly speaking, an instance which 'travels to generation or privation,' at least at the precise moment when it actually attains to either the one or the other (that is, when the phenomenon, not having existed before, is produced, or, having existed before, vanishes), falls under the head, not of the Method of Concomitant Variations, but of the Method of Difference. On the close relation of these two methods to each other, see my Inductive Logic, under the head of the Method of Concomitant Variations.

[47] Hence the common name for these instances, 'Glaring Instances.' Cp. Aph. 20 ad init.

[48] Cp. Aph. 17, and see my note upon the expression, as it occurs there.

in concreto, fit ut alia aliam retundat, deprimat, frangat, et liget; unde obscurantur formae singulae. Inveniuntur autem subjecta nonnulla in quibus natura inquisita prae aliis est in suo vigore, vel per absentiam impedimenti vel per praedominantiam virtutis. Hujusmodi autem *instantiae* sunt maxime *ostensivae* formae. Verum et in his ipsis instantiis adhibenda est cautio, et cohibendus impetus intellectus [49]. Quicquid enim ostentat formam, eamque trudit, ut videatur occurrere intellectui, pro suspecto habendum est, et recurrendum ad *exclusivam* severam et diligentem.

Exempli gratia; sit natura inquisita Calidum. *Instantia Ostensiva* motus expansionis, quae (ut superius dictum est) portio est praecipua [50] formae calidi, est vitrum calendare aëris [51].

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[49] Cp. i. 47. There is sometimes a danger lest these 'glaring instances' should produce an undue effect on the mind, to the prejudice of other instances less striking, but, perhaps, equally or more instructive; and hence the need of caution. This is all that Bacon seems to mean.

[50] In Aph. 20, 'motus expansivus' is given as the 'prima differentia' of heat.

[51] The thermometer, as exhibiting the expansive power of heat, is a good example of a glaring instance. I add some others.

'If the weight of the air were inquired into, the Torricellian experiment, or the barometer, affords an *ostensive instance*, where the circumstance which conceals the weight of the atmosphere in common cases, namely, the pressure of it in all directions, being entirely removed, that weight produces its full effect, and sustains the whole column of mercury in the tube. The barometer affords also an example of the *instantia migrans*, when the change is not total, but only partial or progressive. If it be the weight of the air which supports the mercury in the tube of the barometer, when that weight is diminished, the mercury ought to stand lower. On going to the top of a mountain, the weight of the incumbent air is diminished, because a shorter column of air is to be sustained; the mercury in the barometer ought therefore to sink, and it is found to do so accordingly.

'These are instances in which the action of certain principles is rendered visible by the removal of all the opposing forces. One may be given where it is the distinct and decisive nature of this fact which leads to the result.

'Suppose it were inquired, whether the present land had ever been covered by the sea. If we look at the stratified form of so large a portion of the earth's surface, we cannot but conclude it to be very probable that such land was formed at the bottom of the sea. But the decisive proof is afforded by the shells and corals, or bodies having the perfect shape of shells and corals and of other marine exuviae, which are found im-

Etenim flamma, licet manifesto exhibeat expansionem, tamen propter momentaneam extinctionem non ostendit progressum expansionis. Aqua autem fervens, propter facilem transitionem aquae in vaporem et aërem, non tam bene ostendit expansionem aquae in corpore suo. Rursus ferrum ignitum, et similia, tantum abest ut progressum ostendant, ut contra per retusionem et fractionem spiritus per partes compactas et crassas (quae domant et fraenant expansionem) ipsa expansio non sit omnino conspicua ad sensum [52]. At vitrum calendare clare ostendit expansionem in aëre, et conspicuam et progredientem et durantem, neque transeuntem [53].

Rursus, exempli gratia, sit natura inquisita Pondus. *Instantia Ostensiva* ponderis est argentum vivum [54]. Omnia enim superat pondere magno intervallo, praeter aurum; quod non multo gravius est [55]. At praestantior instantia est ad

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bedded in masses of the most solid rock, and often on the tops of very high mountains.' Playfair, Preliminary Dissertation.

'The laws of crystallography were obscure, and its causes still more so, till Haüy fortunately dropped a beautiful crystal of calcareous spar on a stone pavement, and broke it. In piecing together the fragments, he observed their facets not to correspond with those of the crystal in its entire state, but to belong to another form; and, following out the hint offered by a "*glaring instance*" thus casually obtruded on his notice, he discovered the beautiful laws of the cleavage and the primitive forms of minerals.' Herschel's Discourse, &c., § 191.

In § 365 of the same book, Herschel adduces Magnetism as a 'glaring instance' of polarity, 'and that under circumstances which peculiarly adapt it for the study of this quality.'

[52] This almost looks as if he thought that ignited iron, &c., do undergo expansion, though the amount of it is imperceptible to us. Cp. Aph. 18, Inst. 10.

[53] 'And without passing beyond the condition of air;' as water, for instance, transcends its own condition, when it is converted into steam.

[54] Dr. Hippus (Account of the Novum Organum, in the Library of Useful Knowledge, pt. ii. p. 16) points out that Bacon is not happy in his selection of this instance: 'for gold, which is heavier than quicksilver, becomes fluid also by the application of heat; and quicksilver is solid at a certain temperature.'

[55] Bacon commits the same mistake in the Historia Densi et Rari. He there makes the Specific Gravity of Quicksilver to that of Gold as 19 Den. 9 Gr. to 20 Den., that is as 19·375 to 20. (E. and S., vol. ii. p. 245.) The true ratio is 13·598 to 19·258 of Cast Gold or 19·362 of Stamped Gold, taking the specific gravity of all these substances at zero, as compared with

indicandam formam ponderis argentum vivum quam aurum; quia aurum solidum est et consistens, quod genus referri videtur ad densum; at argentum vivum liquidum est et turgens spiritu, et tamen multis partibus exuperat gravitate diamantem, et ea quae putantur solidissima. Ex quo ostenditur formam gravis sive ponderosi dominari simpliciter in copia materiae, et non in arcta compage [56].

XXV.

Inter praerogativas instantiarum ponemus quarto loco *Instantias Clandestinas* [57], quas etiam *Instantias Crepusculi* ap-

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distilled water at 4° C. The specific gravity of Platinum is still greater than that of gold.

[56] This conception of Weight is perfectly correct. Weight, which is the amount of the earth's attraction on a body, depends not on the consistency of the body, but on the amount of matter contained in it. And, as the amount of matter or mass depends partly on the volume and partly on the density, two bodies of equal volume will vary in weight according to their respective densities.

[57] 'The contrary of glaring are "clandestine instances," where "the nature sought is exhibited in its weakest and most imperfect state." Of this, Bacon himself has given an admirable example in the cohesion of fluids, as a *clandestine instance* of the "*nature* or quality of consistence, or solidity." Yet here, again, the same acute discrimination which enabled Bacon to perceive the analogy which connects fluids with solids, through the common property of cohesive attraction, would, at the same time, have enabled him to draw from it, if properly supported, every consequence necessary to forming just notions of the cohesive force; nor does its reference to the class of clandestine instances at all assist in bringing forward and maturing the final results. When, however, the final result is obtained,—when our induction is complete, and we would verify it,—this class of instances is of great use, being, in fact, frequently no other than that of *extreme cases*, such as we have already spoken of; which, by placing our conclusions, as it were, in violent circumstances, try their temper, and bring their vigour to the test.' Herschel's Discourse, § 193.

'An example of this instance may be given from hydrostatics. If the suspension of water in capillary tubes be inquired into, it becomes very useful to view that effect when it is least, or when the tube ceases to be capillary, and becomes a vessel of a large diameter. The column is then reduced to a slender ring of water, which goes all round the vessel; and this, though now so inconsiderable, has the property of being independent of the size of the vessel, so as to be in all cases the same when the materials are the same. As there can be no doubt that this ring proceeds from the attraction of the sides, and of the part immediately above the water, so there can be no doubt that the capillary suspension, in part at least, is derived from

pellare consuevimus. Eae sunt veluti oppositae *instantiis ostensivis*. Exhibent enim naturam inquisitam in infima virtute, et tanquam in incunabulis et rudimentis suis; tentantem et tanquam primo experientem, sed sub contraria natura latentem et subactam. Sunt autem hujusmodi *instantiae* magni omnino momenti ad inveniendas formas; quia sicut *ostensivae* ducunt facile ad differentias, ita *clandestinae* ducunt optime ad genera [58]; id est, ad naturas illas communes, quarum naturae inquisitae nihil aliud sunt quam limitationes.

Exempli gratia; sit natura inquisita Consistens, sive se determinans; cujus contrarium est Liquidum, sive fluens [59]. *Instantiae clandestinae* sunt illae quae exhibent gradum nonnullum debilem et infimum consistentis in fluido; veluti bulla aquae, quae est tanquam pellicula quaedam consistens et determinata, facta ex corpore aquae. Similiter stillicidia, quae, si adfuerit aqua quae succedat, producunt se in filum admodum tenue, ne discontinuetur aqua; at si non detur talis copia aquae quae succedere possit, cadit aqua in guttis rotundis, quae est figura quae optime aquam sustinet contra discontinuationem [60]. At in ipso temporis articulo, cum desinit

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the same cause. An effect of the opposite kind takes place when a glass vessel is filled with mercury.' Playfair's Preliminary Dissertation.

I confess that, in the former quotation, I do not quite understand what Sir John Herschel means by saying that 'its reference to the class of clandestine instances does not at all assist in bringing forward and maturing the final results.' The mere act of calling it a 'clandestine instance,' of course, does not; but, surely, the fact of noticing the circumstance of cohesion in this extreme case must have contributed largely to forming just notions of the nature and extent of the property.

[58] These instances, being on the extreme border, serve to determine the range of the genus, as the 'glaring instances,' exhibiting a property in its most striking form, serve to direct attention to the most characteristic features of the phenomenon, or, in other words, its differentiae.

[59] Bacon, of course, drew no distinction between the generic term Fluid, including gases, and the specific term Liquid.

[60] The spheroidal shape is due to the cohesion of the molecules of the water. 'In large masses of liquids, the force of gravity overcomes that of cohesion. Hence liquids acted upon by the former force have no special shape; they take that of the vessel in which they are contained. But in smaller masses cohesion gets the upper hand, and liquids present then the spheroidal form. This is seen in the drops of dew on the leaves of plants; it is also seen when a liquid is placed on a solid which it does not moisten; as, for example, mercury upon wood. The experiment may also be made

filum aquae et incipit descensus in guttis, resilit ipsa aqua sursum ad evitandam discontinuationem. Quin in metallis, quae cum funduntur sunt liquida sed magis tenacia, recipiunt se saepe guttae liquefactae sursum, atque ita haerent. Simile quoddam est instantia speculorum puerilium, quae solent facere pueruli in scirpis ex saliva, ubi cernitur etiam pellicula consistens aquae. At multo melius se ostendit hoc ipsum in altero illo ludicro puerili, quando capiunt aquam, per saponem factam paulo tenaciorem, atque inflant eam per calamum cavum, atque inde formant aquam tanquam in castellum bullarum; quae per interpositionem aëris inducit consistentiam eo usque ut se projici nonnihil patiatur absque discontinuatione. Optime autem cernitur hoc in spuma et nive, quae talem induunt consistentiam ut fere secari possint; cum tamen sint corpora formata ex aëre et aqua, quae utraque sunt liquida[61]. Quae omnia non obscure innuunt Liquidum et Consistens esse notiones tantum plebeias, et ad sensum; inesse autem revera omnibus corporibus fugam et evitationem se discontinuandi; eam vero in corporibus homogeneis[62] (qualia sunt liquida) esse debilem et infirmam, in corporibus vero, quae sunt composita ex heterogeneis, magis esse vividam et fortem; propterea quod admotio heterogenei constringit corpora, at subintratio homogenei solvit et relaxat.

Similiter, exempli gratia; sit natura inquisita Attractio, sive Coitio Corporum. *Instantia* circa formam ejus *ostensiva* maxime insignis est magnes. Contraria autem natura attrahenti est non attrahens, licet in substantia simili. Veluti

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with water, by sprinkling upon the surface of the wood some light powder, such as lycopodium or lampblack, and then dropping some water on it.' Ganot's Physics, 6th Ed. of Translation, § 79.

[61] It must be remembered that Bacon was not aware that any body may, by a diminution or increase of temperature, be made solid, liquid, or gaseous.

[62] Bacon was, of course, in error in supposing that liquids, as such, are more homogeneous than solids. The reason that cohesion is more strongly exerted in solids than in liquids is that its intensity decreases as the temperature increases, being counteracted by the repulsive force due to heat. So far from cohesion being greater in heterogeneous than in homogeneous bodies, it is precisely between molecules of the same nature that it exerts its force.

ferrum, quod non attrahit ferrum, quemadmodum nec plumbum plumbum, nec lignum lignum, nec aquam aqua. *Instantia* autem *clandestina* est magnes ferro armatus, vel potius ferrum in magnete armato. Nam ita fert natura, ut magnes armatus in distantia aliqua non trahat ferrum fortius quam magnes non armatus. Verum si admoveatur ferrum, ita ut tangat ferrum in magnete armato, tunc magnes armatus longe majus pondus ferri sustinet quam magnes simplex et inermis, propter similitudinem substantiae ferri versus ferrum[63]; quae operatio erat omnino *clandestina* et latens in ferro, antequam magnes accessisset. Itaque manifestum est formam coitionis esse quippiam quod in magnete sit vividum et robustum, in ferro debile et latens. Itidem notatum est sagittas parvas ligneas absque cuspide ferrea, emissas ex sclopetis grandibus, altius penetrare in materiam ligneam (puta latera navium, aut similia), quam easdem sagittas ferro acuminatas, propter similitudinem substantiae ligni ad lignum, licet hoc ante in ligno latuerit[64]. Itidem, licet aër aërem aut aqua aquam manifesto non trahat in corporibus integris, tamen bulla approximata bullae facilius dissolvit bullam quam si bulla illa altera abesset, ob appetitum coitionis aquae cum aqua et aëris cum aëre[65]. Atque hujusmodi *Instantiae Clandestinae* (quae sunt usus nobilissimi, ut

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[63] The fact is true, but the reason purely fanciful. Mr. Ellis says: 'Before the Novum Organum was published, Galileo had shown' (? maintained) 'that the armature acts by producing a more perfect contact.' He then refers to the Dialogi dei Sistemi massimi, Giornata Terza, Florence Edition of Galileo's Works of 1842, vol. i. p. 440. It should be pp. 440–2. The true reason why magnetic force is increased by armatures will be found in Ganot's Physics, § 663.

It is needless to add that this example of a 'Clandestine Instance' is wholly delusive.

[64] It has been suggested to me by Professor Clifton that, if the facts are correctly stated by Bacon, they are probably due either to the greater velocity with which the wooden arrow would move, in consequence of its lightness, or to the windage in the 'sclopetum' being greater in the case of the tipped arrow than in that of the wooden arrow.

In Henschel's Edition of Du Cange, Paris, 1846, Sclopetum is defined as 'Tormentum bellicum manuale, Gall. escopette' (a 'carbine'). In the first edition of Du Cange, the word does not occur.

[65] The bursting, or, as is sometimes the case, the union of two bubbles in contact is probably due to a complexity of causes, of which capillary attraction is one.

dictum est) in portionibus corporum parvis et subtilibus maxime se dant conspiciendas. Quia massae rerum majores sequuntur formas magis catholicas et generales; ut suo loco dicetur [66].

XXVI.

Inter praerogativas instantiarum ponemus quinto loco *Instantias Constitutivas* [67], quas etiam *Manipulares* appellare con-

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[66] See Aph. 48, Motus Septimus, i. e. 'Motus Congregationis Majoris.'

[67] These instances are neither more nor less than subordinate inductions made with the view of leading up to larger inductions, or afterwards employed for that purpose. Notice the expressions 'tanquam formam minorem,' 'formae particulares,' &c.

'"Collective instances,"' says Sir John Herschel, 'in Bacon's classification, are no other than general facts, or laws of some degree of generality, and are themselves the results of induction. But there is a species of collective instance which Bacon does not seem to have contemplated, of a peculiarly instructive character; and that is, where particular cases are offered to our observation in such numbers at once as to make the induction of their law a matter of ocular inspection. For example, the parabolic form assumed by a jet of water spouted from a round hole, is a *collective instance* of the velocities and directions of the motions of all the particles which compose it *seen at once*, thus leading us, without trouble, to recognise the law of the motion of a projectile. Again, the beautiful figures exhibited by sand strewed on regular plates of glass or metal set in vibration, are *collective instances* of an infinite number of points which remain at rest while the remainder of the plate vibrates; and in consequence afford us, as it were, a sight of the law which regulates their arrangement and sequence throughout the whole surface. The beautifully coloured lemniscates seen around the optic axes of crystals exposed to polarised light afford a superb example of the same kind, pointing at once to the general mathematical expression of the law which regulates their production. (See Phil. Trans. 1819.) Of such collective instances as these, it is easy to see the importance, and its reason. They lead us to a general law by an induction which offers itself spontaneously, and thus furnish advanced points in our enquiries; and when we start from these, already "a thousand steps are lost."

'A fine example of a collective instance is that of the system of Jupiter or Saturn with its satellites. We have here, in miniature, and seen at one view, a system similar to that of the planets about the sun; of which, from the circumstance of our being involved in it, and unfavourably situated for seeing it otherwise than in detail, we are incapacitated from forming a general idea but by slow progressive efforts of reason. Accordingly, the contemplation of the *circumjovial planets* (as they were called) most materially assisted in securing the admission of the Copernican system.' Discourse, &c., §§ 194–5.

suevimus. Eae sunt quae constituunt unam speciem naturae inquisitae tanquam Formam Minorem. Cum enim formae legitimae (quae sunt semper convertibiles cum naturis inquisitis) lateant in profundo nec facile inveniantur, postulat res et infirmitas humani intellectus ut formae particulares[68], quae sunt congregativae *Manipulorum* quorundam instantiarum (neutiquam vero omnium) in notionem aliquam communem, non negligantur, verum diligentius notentur. Quicquid enim unit naturam, licet modis imperfectis, ad inventionem formarum viam sternit. Itaque instantiae, quae ad hoc utiles sunt non sunt contemnendae potestatis, sed habent nonnullam praerogativam.

Verum in his diligens est adhibenda cautio, ne intellectus humanus, postquam complures ex istis formis particularibus

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Professor Playfair adduces as examples of 'Collective Instances' the three laws of Kepler, which subsequently, in the hands of Newton, led to the discovery of the great principle of Gravitation. 'These discoveries were all made before Bacon wrote, but he is silent concerning them; for the want of mathematical knowledge concealed from his view some of the most splendid and interesting parts of science.'

'Astronomy is full of such collective instances, and affords them, indeed, of the second and third order, that is to say, two or three times generalised. The astronomer observes nothing but that a certain luminous disk, or perhaps merely a luminous point, is in a certain position, in respect of the planes of the meridian and the horizon, at a certain moment of time. By comparing a number of such observations, he finds that this luminous point moves in a certain plane, with a certain velocity, and performs a revolution in a certain time. Thus, the periodic time of a planet is itself a collective fact, or a single fact expressing the result of many hundred observations. This holds with respect to each planet, and with respect to each element, as it is called, of the planet's orbit, every one of which is a general fact, expressing the result of an indefinite number of particulars. This holds still more remarkably of the inferences which extend to the distances of the planet from the earth, or from the sun. The laws of Kepler are therefore collective facts of the second, or even a higher order; or such as comprehend a great number of general facts, each of which is itself a general fact, including many particulars.' Preliminary Dissertation.

68 These formae minores or particulares correspond with the axiomata infima or some of the lower degrees of the axiomata media of Bk. i. (see, for instance, i. 104). They might be described as the definitions of specific (though still general) exemplifications of the nature under examination. Cp. the last paragraph of the Aphorism.

adinvenerit atque inde partitiones sive divisiones naturae inquisitae confecerit, in illis omnino acquiescat, atque ad inventionem legitimam Formae Magnae se non accingat, sed praesupponat naturam velut a radicibus esse multiplicem et divisam, atque ulteriorem naturae unionem, tanquam rem supervacuae subtilitatis et vergentem ad merum abstractum, fastidiat et rejiciat.

Exempli gratia; sit natura inquisita Memoria[69], sive Excitans et Adjuvans memoriam. *Instantiae constitutivae* sunt, ordo sive distributio, quae manifesto juvat memoriam; item Loci in memoria artificiali, qui aut possunt esse loci secundum proprium sensum, veluti janua, angulus, fenestra, et similia, aut possunt esse personae familiares et notae, aut possunt esse quidvis ad placitum (modo in ordine certo ponantur), veluti animalia, herbae; etiam verba, literae, characteres, personae historicae, et caetera; licet nonnulla ex his magis apta sint et commoda, alia minus. Hujusmodi autem Loci memoriam insigniter juvant, eamque longe supra vires naturales exaltant. Item carmina facilius haerent et discuntur memoriter quam prosa. Atque ex isto *manipulo* trium instantiarum, videlicet ordinis, locorum artificialis memoriae, et versuum, constituitur species una auxilii ad Memoriam. Species autem illa *Abscissio Infiniti*[70] recte vocari possit. Cum enim quis aliquid reminisci aut revocare in memoriam nititur, si nullam praenotionem habeat aut perceptionem ejus quod quaerit, quaerit certe et molitur et hac illac discurrit, tanquam in infinito. Quod si certam aliquam praenotionem habeat, statim abscinditur infinitum, et fit discursus memoriae magis in vicino. In tribus autem

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[69] This example is interesting in connection with i. 127, as shewing that Bacon did not confine his examples any more than the scope of his philosophical reform to what is usually called Natural Philosophy.

On his doctrine of Memory and the Aids to Memory, in general, see De Augmentis, lib. v. cap. 5.

Most of the mental phenomena as well as the artificial aids to memory here described would now be explained by the doctrine of Association of Ideas.

[70] In the De Augmentis, the expression 'Praenotio' (which also occurs below) is put forward most prominently to describe this species. 'Praenotionem vocamus abscissionem quandam investigationis infinitae.'

illis instantiis quae superius dictae sunt, praenotio perspicua est et certa. In prima videlicet, debet esse aliquid quod congruat cum ordine; in secunda debet esse imago quae relationem aliquam habeat sive convenientiam ad illa loca certa; in tertia, debent esse verba quae cadant in versum. Atque ita abscinditur infinitum. Aliae autem instantiae dabunt hanc alteram speciem; ut quicquid deducat intellectuale ad feriendum sensum[71] (quae ratio etiam praecipue viget in artificiali memoria) juvet memoriam. Aliae instantiae dabunt hanc alteram speciem; ut quae faciunt impressionem in affectu forti, incutientia scilicet metum, admirationem, pudorem, delectationem, juvent memoriam. Aliae instantiae dabunt hanc alteram speciem; ut quae maxime imprimuntur a mente pura et minus praeoccupata ante vel post, veluti quae discuntur in pueritia aut quae commentamur ante somnum[72], etiam primae quaeque rerum vices, magis haereant in memoria. Aliae instantiae dabunt hanc alteram speciem; ut multitudo circumstantiarum sive ansarum juvet memoriam, veluti scriptio per partes non continuatas, lectio, sive recitatio voce alta. Aliae denique instantiae dabunt hanc alteram speciem; ut quae expectantur et attentionem excitant melius haereant, quam quae praetervolant. Itaque si scriptum aliquod vicies perlegeris, non tam facile illud memoriter disces quam si illud legas decies, tentando interim illud recitare, et ubi deficit memoria inspiciendo librum. Ita ut sint veluti sex Formae Minores eorum quae juvant Memoriam; videlicet abscissio infiniti; deductio intellectualis ad sensibile;

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[71] In the De Augmentis, this species is called 'Emblema,' and is described at greater length than here, as well as illustrated. See the end of bk. v.

[72] The probable cause of this phenomenon (of which some striking instances will be found in Dr. Carpenter's Mental Physiology, ch. 13) is that we repeatedly recur to these thoughts during sleep, though, on waking, we have forgotten that we did so. It belongs to the class of phenomena described by Leibnitz as 'obscure ideas,' by Hamilton as 'Latent Mental Modifications,' by Dr. Carpenter as 'Unconscious Cerebration,' and more happily by Mr. Lewes as 'Subconsciousness.' Awaking at an appointed hour is a good and familiar instance of the power which the mind actually exerts during sleep, though all recollection of its exertion may have passed away.

impressio in affectu forti; impressio in mente pura; multitudo ansarum; praeexpectatio.

Similiter, exempli gratia; sit natura inquisita Gustus, sive Gustatio. *Instantiae* quae sequuntur sunt *Constitutivae:* videlicet, quod qui non olfaciunt, sed sensu eo a natura destituti sunt, non percipiant aut gustu distinguant cibum rancidum aut putridum, neque similiter alliatum aut rosatum, aut hujusmodi[73]. Rursus, illi, qui per accidens nares habent per descensum rheumatis obstructas, non discernunt aut percipiunt aliquid putridum aut rancidum aut aqua rosacea inspersum. Rursus, qui afficiuntur hujusmodi rheumate, si in ipso momento, cum aliquid foetidum aut odoratum habent in ore sive palato, emungant fortiter, in ipso instanti manifestam perceptionem habent rancidi vel odorati. Quae instantiae dabunt et constituent hanc speciem, vel partem potius gustus; ut sensus gustationis ex parte nihil aliud sit quam olfactus interior, transiens et descendens a narium meatibus superioribus in os et palatum[74]. At contra, salsum et dulce et acre et acidum et austerum et amarum, et similia, haec (inquam) omnia aeque sentiunt illi in quibus olfactus deest aut obturatur, ac quisquam alius; ut manifestum sit sensum gustus esse compositum quiddam ex olfactu interiori et tactu quodam exquisito[75]; de quo nunc non est dicendi locus.

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[73] These instances are, perhaps, slightly exaggerated. But, so far as they are true, they are well explained by the following extract from Mr. Bain's 'Senses and Intellect,' 3rd Ed., pp. 158–9: 'Tastes, properly so called, affect only the gustatory nerves, and are therefore the same whether the nostrils are opened or closed. But many sapid bodies are also odorous. In the act of expiration accompanying mastication, especially the instant after deglution, the odorous particles are carried into the cavities of the nose, and affect the sense of smell, or make their odour apparent. This effect is what we term *flavour*. Some bodies, as cinnamon, have hardly any taste, but a flavour, in other words an odour, brought out by mastication.'

[74] It must be borne in mind, however, that, though the sensations of smell and taste are closely associated, and their organs are in close proximity, they are still perfectly distinct.

[75] In the case of both taste and smell, the precise mode of action on the organ is very obscure, but, in each case, it is probably chemical. Touch is, of course, a condition common to all the five external senses, various as they are in their characteristics, and impossible as it is to reduce them, one to the other.

Similiter, exempli gratia; sit natura inquisita Communicatio Qualitatis absque Commistione Substantiae. Instantia Lucis dabit vel constituet unam speciem communicationis; Calor vero et Magnes alteram. Communicatio enim lucis est tanquam momentanea, et statim perit, amota luce originali. At calidum et virtus magnetica, postquam tramissa fuerint vel potius excitata in alio corpore, haerent et manent ad tempus non parvum, amoto primo movente.

Denique magna est omnino praerogativa *instantiarum constitutivarum*, ut quae plurimum faciant et ad definitiones (praesertim particulares) et ad divisiones sive partitiones naturarum; de quo non male dixit Plato, *Quod habendus sit tanquam pro Deo, qui definire et dividere bene sciat*[76].

XXVII.

Inter praerogativas instantiarum ponemus sexto loco *Instantias Conformes*[77], sive *Proportionatas;* quas etiam *Parallelas*,

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[76] Mr. Kitchin quotes Phaedrus, 266 A (it should be 266 B): *Τούτων δὴ ἔγωγε αὐτός τε ἐραστής, ὦ Φαῖδρε, τῶν διαιρέσεων καὶ συναγωγῶν, ἵν' οἷός τε ὦ λέγειν τε καὶ φρονεῖν· ἐάν τέ τιν' ἄλλον ἡγήσωμαι δυνατὸν εἰς ἓν καὶ ἐπὶ πολλὰ πεφυκόθ' ὁρᾶν, τοῦτον διώκω κατόπισθε μετ' ἴχνιον ὥστε θεοῖο.*

[77] This very important class of instances consists of 'Analogies' drawn from objects or qualities in many respects dissimilar—at all times one of the most fertile sources of suggestion both for scientific discoveries and practical inventions. The imaginative and truly philosophical type of mind which is adapted to note these resemblances is well described by Bacon in i. 55.

Professor Playfair, giving examples of these instances, says: 'Such are the telescope and microscope, in the works of art, compared with the eye in the works of nature. This, indeed, is an analogy which goes much beyond the mere exterior; it extends to the internal structure, and to the principle of action, which is the same in the eye and in the telescope,—to the *latent schematism*, in the language of Bacon, as far as material substance is concerned. It was the experiment of the *camera obscura* which led to the discovery of the formation of the images of external objects in the bottom of the eye by the action of the crystalline lens, and the other humours of which the eye is formed.

'Among the instances of conformity, those are the most useful which enable us to compare productions of an unknown formation, with similar productions of which the formation is well understood. Such are basalt, and the other trap rocks, compared with the lava thrown out from volcanoes. They have a structure so exactly similar, that it is hardly possible to doubt that their origin is the same, and that they are both produced

sive *Similitudines Physicas*, appellare consuevimus. Eae vero sunt, quae ostendunt similitudines et conjugationes rerum, non in formis minoribus (quod faciunt *instantiae constitutivae*) sed plane in concreto [78]. Itaque sunt tanquam primi et infimi gradus ad unionem naturae. Neque constituunt aliquod axioma statim ab initio, sed indicant et observant tantum quendam consensum corporum [79]. Attamen licet non multum promoveant ad inveniendas formas, nihilominus magna cum utilitate revelant partium universi fabricam, et in membris ejus exercent veluti anatomiam quandam; atque proinde

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by the action of subterraneous fire. There are, however, amid their similarity, some very remarkable differences in the substances which they contain, the trap rocks containing calcareous spar, and the lava never containing any. On the supposition that they are both of igneous origin, is there any circumstance, in the conditions in which heat may have been applied to them, which can account for this difference? Sir James Hall, in a train of most philosophical and happily-contrived experiments, has explained the nature of those conditions, and has shown that the presence of calcareous spar, or the want of it, may arise from the greater or less compression under which the fusion of the basalt was performed. This has served to explain a great difficulty in the history of the mineral kingdom.

'Comparative anatomy is full of analogies of this kind, which are most instructive, and useful guides to discovery. It was by remarking in the blood-vessels, a contrivance similar to the valves used in hydraulic engines, for preventing the counter-current of a fluid, that Harvey was led to the discovery of the circulation of the blood. The analogies between natural and artificial productions are always highly deserving of notice.' Preliminary Dissertation.

It is by the bold use of analogies of this kind that modern physicists have been able to trace the correlations of the various physical forces; that modern philologists have been able to refer to the same families, languages of apparently the most dissimilar character; and that modern jurists and moralists have detected in laws, institutions, customs, and feelings amongst the most widely scattered races and at the most various stages of civilisation a common origin and a common meaning. Though the strict use of logical method is indispensable to demonstration and verification, it is the observation of analogies, and those often very remote ones, that generally sets us on the track of great discoveries.

[78] That is, they are concerned with individual observations, and not with inductive generalisations, as are the Instantiae Constitutivae.

[79] They serve to suggest axioms, rather than to establish them. See note 77. It is curious that considerations of this kind did not lead Bacon to attach greater importance to the office of the Imagination in scientific discovery.

veluti manu-ducunt interdum ad axiomata sublimia et nobilia, praesertim illa quae ad mundi configurationem pertinent, potius quam ad naturas et formas simplices[80].

Exempli gratia; Instantiae Conformes sunt quae sequuntur: speculum, et oculus; et similiter fabrica auris, et loca reddentia echo. Ex qua conformitate, praeter ipsam observationem similitudinis, quae ad multa utilis est, proclive est insuper colligere et formare illud axioma; videlicet, organa sensuum et corpora quae pariunt reflexiones ad sensus esse similis naturae. Rursus ex hoc ipso admonitus intellectus non aegre insurgit ad axioma quoddam altius et nobilius. Hoc nimirum; nihil interesse inter consensus sive sympathias corporum sensu praeditorum, et inanimatorum sine sensu, nisi quod in illis accedat spiritus animalis[81] ad corpus ita[82] dispositum, in his autem absit. Adeo ut quot sint consensus[83] in corporibus inanimatis, tot possint esse sensus in animalibus, si essent perforationes in corpore animato ad discursum spiritus animalis in membrum rite dispositum, tanquam in organum idoneum. Et rursus, quot sint sensus in animalibus, tot sint proculdubio motus in corpore inanimato ubi spiritus animalis abfuerit; licet necesse sit multo plures esse motus in corporibus inanimatis quam sensus in animatis, propter paucitatem organorum sensus. Atque hujus rei ostendit se exemplum valde manifestum in doloribus. Etenim quum sint plura genera doloris in animalibus, et tanquam varii illius

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[80] This is hardly the case. Analogy has played an important part in suggesting the laws of Light, Heat, Sound, Electricity, Gravitation, &c.

[81] See note on 'spiritus animalium' in Aph. 13. Inst. 38, and the passage in the Historia Vitae et Mortis (E. and S., vol. ii. pp. 214, 215) there referred to. In the latter passage, Bacon distinguishes between the 'spiritus mortuales,' and the 'spiritus vitalis' (or animatus) which is 'superadded' in all animated beings.

In ii. 40 there are some extremely curious speculations on 'actio et motus spiritus, qui includitur in corporibus tangibilibus.' Cp. also i. 50, with note 82.

[82] Mr. Kitchin proposes (I think needlessly) to read 'rite.' 'Ita dispositum' means 'so disposed as to receive impressions,' 'disposed accordingly.'

[83] On 'Operationes per consensus aut fugas (qui sextus modus operandi est),' see ii. 50. Cp. also 'Aditus ad Historiam Sympathiae et Antipathiae Rerum' (E. and S., vol. ii. p. 81), Sylva Sylvarum, Exps. 800–830.

characteres (veluti alius est dolor ustionis, alius frigoris intensi, alius puncturae, alius compressionis, alius extensionis, et similium), certissimum est omnia illa, quoad motum, inesse corporibus inanimatis; veluti ligno aut lapidi, cum uritur, aut per gelu constringitur, aut pungitur, aut scinditur, aut flectitur, aut tunditur, et sic de aliis; licet non subintrent sensus, propter absentiam spiritus animalis.

Item *instantiae conformes* (quod mirum fortasse dictu) sunt radices et rami plantarum. Omne enim vegetabile intumescit, et extrudit partes in circumferentiam, tam sursum quam deorsum. Neque alia est differentia radicum et ramorum, quam quod radix includatur in terra, et rami exponantur aëri et soli[84]. Si quis enim accipiat ramum tenerum et vegetum arboris, atque illum reflectat in aliquam terrae particulam, licet non cohaereat ipsi solo, gignit statim non ramum, sed radicem. Atque vice versa, si terra ponatur superius, atque ita obstruatur lapide aut aliqua dura substantia, ut planta cohibeatur nec possit frondescere sursum, edet ramos in aërem deorsum.

Item *instantiae conformes* sunt gummi arborum, et pleraeque gemmae rupium[85]. Utraque enim nil aliud sunt quam exudationes et percolationes succorum: in primo genere scilicet, succorum ex arboribus; in secundo, ex saxis; unde

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[84] This is, of course, an error, but it is not entirely without excuse. 'In the young state there is no distinction between stem and root, as regards structure; both being cellular, and an extension of each other in opposite directions. The root is afterwards distinguished from the stem, by the want of a provision for the development of leaf-buds, and by increasing from above downwards. Such plants, however, as the Moutan Paeony, the Plum-tree, Pyrus Japonica, and especially Anemone Japonica, have a power of forming buds on their roots.' Balfour's Manual of Botany, § 119.

M. Bouillet, speaking of this example and of some of those given below, says: 'Ne trouve-t-on pas dans toutes ces indications le germe de deux théories qui ont été développées de nos jours avec un grand succès, celle des métamorphoses des organes des plantes, qu'ont défendues Goethe et M. de Candolle, et celle des analogues, qui a fait l'objet spécial des études de M. Geoffroy-St.-Hilaire ?'

[85] This is simply a fancy, and, like some of Bacon's other instances in this Aphorism, is an example of false rather than of true Analogy. Gems are due to Crystallisation.

gignitur claritudo et splendor in utrisque, per percolationem nimirum tenuem et accuratam. Nam inde fit etiam, quod pili animalium non sint tam pulchri et tam vividi coloris quam avium plumae complures: quia succi non tam delicate percolantur per cutem quam per calamum.

Item *instantiae conformes* sunt scrotum in animalibus masculis, et matrix in femellis. Adeo ut nobilis illa fabrica per quam sexus differunt (quatenus ad animalia terrestria), nil aliud videatur esse, quam secundum exterius et interius[86]; vi scilicet majore caloris genitalia in sexu masculo protrudente in exterius, ubi in femellis nimis debilis est calor quam ut hoc facere possit; unde accidit quod contineantur interius.

Item *instantiae conformes* sunt pinnae piscium[87], et pedes quadrupedum, aut pedes et alae volucrum; quibus addidit Aristoteles quatuor volumina in motu serpentum[88]. Adeo ut in fabrica universi motus viventium plerunque videatur expediri per quaterniones artuum sive flexionum.

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[86] 'This remark seems to have been suggested by a similar passage in Telesius, *De Rerum Natura*, vi. 18:—"Masculo . . . . magnus datus est calor, qui et membrum genitale foras propellat et sanguinem multum beneque omnem compactum conficiat, &c. Foeminae autem . . . languens inditus est calor, qui neque genitale vas foras propellere nec e semine spiritum educere queat." The doctrine however of this passage was first taught by Galen, from whom Telesius derived it. See Galen, *De Usu Partium*, xiv. 6.' Mr. Ellis' note.

[87] This analogy, so far as birds, quadrupeds, and fishes are concerned, is a good one. It occurs both in Aristotle and Pliny. See Arist. Hist. An. i. 5 (Berlin Ed., p. 490 a. 26, &c.): *Κινεῖται δὲ τὰ κινούμενα πάντα τέτταρσι σημείοις ἢ πλείοσι, τὰ μὲν ἔναιμα τέτταρσι μόνον, οἷον ἄνθρωπος μὲν χερσὶ δυσὶ καὶ ποσὶ δυσίν, ὄρνις δὲ πτέρυξι δυσὶ καὶ ποσὶ δυσί, τὰ δὲ τετράποδα καὶ ἰχθύες τὰ μὲν τέτταρσι ποσίν, οἱ δὲ τέτταρσι πτερυγίοις. Ὅσα δὲ δύο ἔχει πτερύγια ἢ ὅλως μή, οἷον ὄφις, τέτταρσι σημείοις οὐθὲν ἧττον· αἱ γὰρ καμπαὶ τέτταρες, ἢ δύο σὺν τοῖς πτερυγίοις. Ὅσα δ' ἄναιμα ὄντα πλείους πόδας ἔχει, εἴτε πτηνὰ εἴτε πεζά, σημείοις κινεῖται πλείοσιν, κ.τ.λ.* Cp. De Incessu Animalium, i. 7, 8 (Berlin Ed., pp. 707–8). See also Pliny, Nat. Hist. ix. ch. 20 (sect. 73): 'Ideo pinnarum quoque fiunt discrimina, quae pedum vice sunt datae piscibus: nullis supra quaternas: quibusdam binae, aliquibus nullae. In Fucino tantum lacu piscis est, qui octonis pinnis natat.'

[88] See the two passages from Aristotle referred to in the last note. This is a 'glaring instance' of the tendency of the human mind 'supponere majorem ordinem et aequalitatem in rebus quam invenit' et 'affingere parallela et correspondentia et relativa quae non sunt.'

Item dentes in animalibus terrestribus, et rostra in avibus, sunt *instantiae conformes;* unde manifestum est, in omnibus animalibus perfectis fluere duram quandam substantiam versus os.

Item non absurda est similitudo et conformitas illa, ut homo sit tanquam planta inversa. Nam radix nervorum et facultatum animalium est caput; partes autem seminales sunt infimae, non computatis extremitatibus tibiarum et brachiorum. At in planta, radix (quae instar capitis est) regulariter infimo loco collocatur; semina autem supremo.

Denique illud omnino praecipiendum est et saepius monendum; ut diligentia hominum in inquisitione et congerie Naturalis Historiae deinceps mutetur plane, et vertatur in contrarium ejus quod nunc in usu est. Magna enim hucusque atque adeo curiosa fuit hominum industria in notanda rerum varietate atque explicandis accuratis animalium, herbarum, et fossilium differentiis; quarum pleraeque magis sunt lusus naturae quam seriae alicujus utilitatis versus scientias. Faciunt certe hujusmodi res ad delectationem, atque etiam quandoque ad praxin; verum ad introspiciendam naturam parum aut nihil. Itaque convertenda plane est opera ad inquirendas et notandas rerum similitudines et analoga, tam in integralibus quam partibus. Illae enim sunt quae naturam uniunt, et constituere scientias incipiunt[89].

Verum in his omnino est adhibenda cautio gravis et severa; ut accipiantur pro *instantiis conformibus* et *proportionatis* illae, quae denotant similitudines (ut ab initio diximus) physicas; id est, reales et substantiales et immersas in natura, non fortuitas et ad speciem; multo minus superstitiosas aut curiosas, quales naturalis magiae scriptores[90] (homines levissimi, et in rebus tam seriis quales nunc agimus vix nominandi) ubique ostentant; magna cum vanitate et desipientia, inanes simili-

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[89] These remarks are hardly worthy of Bacon's penetration. To the successful investigation of science it is quite as essential to note the differences as the resemblances of things. His contrast of the two opposed mental types in i. 55 is far juster and sounder than this paragraph.

[90] Cp. De Augmentis, iii. 5, and Aditus ad Historiam Sympathiae et Antipathiae Rerum (E. and S., vol. ii. p. 81).

tudines et sympathias rerum describentes atque etiam quandoque affingentes.

Verum his missis, etiam in ipsa configuratione mundi in majoribus non sunt negligendae *instantiae conformes;* veluti Africa, et regio Peruviana cum continente se porrigente usque ad Fretum Magellanicum. Utraque enim regio habet similes isthmos et similia promontoria, quod non temere accidit [91].

Item Novus et Vetus Orbis; in eo quod utrique orbes versus septentriones lati sunt et exporrecti, versus austrum autem angusti et acuminati [92].

Item *instantiae conformes* nobilissimae sunt frigora intensa in media (quam vocant) aëris regione, et ignes acerrimi qui saepe reperiuntur erumpentes ex locis subterraneis; quae duae res sunt ultimitates et extrema; naturae scilicet frigidi versus ambitum coeli, et naturae calidi versus viscera

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[91] Bacon seems to be comparing the *western* or *corresponding* sides of the two continents. The conformity of the *opposite* sides is also remarkable, the projections on one side answering roughly to the recesses on the other.

[92] Humboldt discusses these and similar phenomena at some length. See Col. Sabine's Translation of the Kosmos, vol. i. p. 280, &c. While acknowledging that 'little can be ascertained by investigation respecting the causal connection of the great phenomena appertaining to the formation of our continents, and to the analogies and contrasts presented by their configuration,' he suggests two principal causes, acting in succession, which may have determined such configuration. 'Slight disturbances in the equilibrium of the elastic forces in the interior of our planet may have determined their action more towards the northern than the southern hemisphere, and have occasioned the elevation of the dry land in the eastern hemisphere in the form of a wide connected mass, having its major axis almost parallel to the equator,—and in the western and more oceanic hemisphere, in a comparatively narrow band, following the direction of the meridian.' Again, 'Our Atlantic Ocean presents the characteristics of a valley. It is as if the flow of the waters had been directed first towards the north-east, then towards the north-west, and then again towards the north-east. The parallelism of the coasts north of 10° of South latitude, the projecting and re-entering angles, the convexity of Brazil opposite to the Gulf of Guinea, and the convexity of Africa to the Gulf of Mexico, all favour this view, which at first may seem too hazardous. In the Atlantic Valley, as is indeed usually the case in the form of large masses of land, coasts deeply indented and fringed with many islands are placed opposite to those of a contrary character.'

terrae[93]; per antiperistasin[94], sive rejectionem naturae contrariae.

Postremo autem in axiomatibus scientiarum notatu digna est *conformitas instantiarum.* Veluti tropus rhetoricae, qui dicitur *Praeter Expectatum*, conformis est tropo musicae, qui vocatur *Declinatio Cadentiae*[95]. Similiter, postulatum mathematicum[96], ut *quae eidem tertio aequalia sunt etiam inter se*

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[93] It is true that the higher we ascend in the atmosphere, the colder it is, and the lower we descend into the interior of the earth, the warmer it is; but these two sets of facts depend on different causes, and hence they do not really constitute an Instantia Conformis.

On the internal heat of the earth and the causes of volcanoes and earthquakes, see Lyell's Principles of Geology, chs. on the Causes of Earthquakes and Volcanoes (12th Ed., chs. 32, 33).

[94] Cp. ii. 12. Inst. 24. The word *ἀντιπερίστασις* is of not uncommon occurrence in Aristotle. See, for instance, Physics, viii. 10 (p. 267 a. 16): *διὸ καὶ ἐν ἀέρι καὶ ἐν ὕδατι γίνεται ἡ τοιαύτη κίνησις, ἣν λέγουσί τινες ἀντιπερίστασιν εἶναι.* Meteorologica, i. 12 (p. 348 b. 2): *ἀλλ' ἐπειδὴ ὁρῶμεν ὅτι γίνεται ἀντιπερίστασις τῷ θερμῷ καὶ τῷ ψυχρῷ ἀλλήλοις.* On the former passage, Bonitz quotes the following definition from Simplicius: *ἀντιπερίστασίς ἐστιν, ὅταν ἐξωθουμένου τινὸς σώματος ἀνταλλαγὴ γένηται τῶν τόπων, καὶ τὸ μὲν ἐξωθῆσαν ἐν τῷ τοῦ ἐξωθηθέντος στῇ τοπῷ, τὸ δ' ἐξωθηθὲν τὸ προσεχὲς ἐξωθῇ, ἕως ἂν τὸ ἔσχατον ἐν τῷ τόπῳ γένηται τοῦ πρώτου ἐξωθήσαντος.*

[95] These are the 'Axiomata quae particularium scientiarum non sint propria, sed pluribus earum in commune competant' which constitute one division of the Philosophia Prima. See De Augmentis, iii. 1. Aristotle employs the word *ἀξιώματα* in a similar, though not exactly the same sense, for the principles common to all sciences. See note on i. 7.

[95] 'Is not the trope of music, to avoid or slide from the close or cadence, common with the trope of rhetoric of deceiving expectation?' Advancement of Learning, bk. ii. (E. and S., vol. iii. pp. 348–9). 'Tropus ille Musicus, a clausula aut cadentia (quam vocant), cum jamjam adesse videatur, placide elabendi, convenit cum tropo Rhetorico expectationem eludendi.' De Augm. iii. 1. The following note, communicated by Professor Sir F. A. Gore Ouseley, I borrow from Mr. Kitchin: 'At first I thought it meant a "Cadenza d' Inganno," or "false cadence;" but I have now satisfied myself that such a thing was unknown in Bacon's time. I am rather inclined to think it refers to a species of false close, such as we find in the last bar but two of Tallis's Nunc Dimittis in D, where the Harmony proceeds to $^{5}_{4}$ and $\sharp^{5}_{3}$ on A for a Bass, as though it were about to close immediately on the chord of D; when suddenly the Tenor strikes a $C\natural$, which necessitates a modulation into the chord of G, thus leading to a "Plagal Close."'

[96] Generally, and more properly called an Axiom.

sint aequalia, conforme est cum fabrica syllogismi in logica, qui unit ea quae conveniunt in medio [97]. Denique multum utilis est in quamplurimis sagacitas quaedam in conquirendis et indagandis conformitatibus et similitudinibus physicis.

XXVIII.

Inter *praerogativas instantiarum,* ponemus septimo loco *Instantias Monodicas* [98]; quas etiam *Irregulares* sive *Heteroclitas* (sumpto vocabulo a grammaticis) appellare consuevimus. Eae sunt, quae ostendunt corpora in concreto, quae videntur esse extravagantia et quasi abrupta in natura, et minime convenire cum aliis rebus ejusdem generis. Etenim *instantiae conformes* sunt similes alterius, at *instantiae monodicae* sunt sui similes. Usus vero *instantiarum monodicarum* est talis qualis est *instantiarum clandestinarum:* viz. ad

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[97] 'Quae in eodem tertio conveniunt, et inter se conveniunt, regula est itidem ex Mathematicis; verum simul tam potens in Logica, ut syllogismi sit fundamentum.' De Augm. iii. 1. There, and in the corresponding passage of the Advancement of Learning, several other examples of these 'Axioms' are given.

The Mathematical Axiom that 'things which are equal to the same thing are equal to one another' is, strictly speaking, only applicable to Logic, if we quantify the predicate. But the dictum de omni et nullo, the maxim 'nota notae est nota rei ipsius,' and syllogistic principles such as the 'Canon of Reasoning in the First Figure' which I have given in my Deductive Logic (6th Ed., p. 91), are analogous ('conformia') to it. In the passage in the text, this is all that Bacon's language implies.

The later examples in this Aphorism supply another illustration of i. 127. Cp. Aphs. 26, 35.

[98] Properly 'monadicas.' See note on i. 45. In the edition of the Novum Organum, published at Amsterdam in 1660, 'monadica' is read throughout the Second Book, though, curiously, the correction is not made in the First Book.

Comets, Double Stars, the occasional crescent-shape of Venus, of Mercury, and of the Moon, Earthquakes, Volcanoes, Cyclones, Meteoric Stones, the peculiarities in the relation between the expansion and temperature of water as well as of bismuth and the casting-metals generally, are all good examples of what Bacon means by these instances. Similarly, in law, we might adduce as 'monadic instances' Gavelkind and Borough English, or, in moral sentiment, Suttee, Duelling, the Levirate, &c. It is sometimes indifferent whether we refer an example to this head or the next of Instantiae Deviantes, as is the case with one or two of the examples given above.

evehendam et uniendam naturam ad invenienda genera sive communes naturas, limitandas postea per differentias veras. Neque enim desistendum ab inquisitione donec proprietates et qualitates, quae inveniuntur in hujusmodi rebus quae possunt censeri pro miraculis naturae, reducantur et comprehendantur sub aliqua forma sive lege certa: ut irregularitas sive singularitas omnis reperiatur pendere ab aliqua forma communi; miraculum vero illud sit tandem solummodo in differentiis accuratis et gradu et concursu raro, et non in ipsa specie: ubi nunc contemplationes hominum non procedant ultra quam ut ponant hujusmodi res pro secretis et magnalibus naturae, et tanquam incausabilibus, et pro exceptionibus regularum generalium [99].

Exempla *instantiarum monodicarum* sunt, sol et luna, inter astra; magnes, inter lapides; argentum vivum, inter metalla; elephas, inter quadrupedes; sensus veneris, inter genera tac-

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[99] These remarks are highly philosophical. We ought never to rest till exceptions are explained, and, when explained, they will usually be found to fall under some general law of nature, or, in the case of moral and social phenomena, to be what Mr. Tylor has happily called 'survivals' of some state of things which was far more general in the past. The history of language, it may be noticed, is peculiarly rich in phenomena of this kind.

Sir John Herschel illustrates this instance as follows: 'The discovery of the magnetism of nickel, which, though inferior to that of iron, is still considerable; that of cobalt, yet feebler, and that of titanium, which is only barely perceptible, have effectually broken down the imaginary limit between iron and the other materials of the world, and established the existence of that general law of continuity which it is one chief business of philosophy to trace throughout nature. The more recent discoveries of M. Arago have completed this generalisation, by showing that there is no substance but which, under proper circumstances, is capable of exhibiting unequivocal signs of magnetic virtue. And to obliterate all traces of that line of separation which was once so broad, we are now enabled, by the great discovery of Oersted, to communicate at and during pleasure to a coiled wire of any metal indifferently all the properties of a magnet;—its attraction, repulsion, and polarity; and *that* even in a more intense degree than was previously thought to be possible in the best natural magnets.' Discourse, &c., § 364. Appended to the later editions of Sir W. R. Grove's Correlation of Physical Forces is an admirable Address, delivered before the British Association, on the Law of Continuity.

tus; odor venaticus in canibus, inter genera olfactus. Etiam S litera apud grammaticos, habetur pro monodica; ob facilem compositionem quam sustinet cum consonantibus, aliquando duplicibus, aliquando triplicibus[1]; quod nulla alia litera facit. Plurimi autem faciendae sunt hujusmodi instantiae; quia acuunt et vivificant inquisitionem, et medentur intellectui depravato a consuetudine et ab iis quae fiunt plerunque.

XXIX.

Inter *praerogativas instantiarum*, ponemus loco octavo *Instantias Deviantes*[2]; errores scilicet naturae, et vaga, ac monstra: ubi natura declinat et deflectit a cursu ordinario. Differunt enim errores naturae ab *instantiis monodicis* in hoc; quod monodicae sint miracula specierum, at errores sint miracula individuorum. Similis autem fere sunt usus; quia rectificant intellectum adversus consueta, et revelant formas communes. Neque enim in his etiam desistendum ab inquisitione donec inveniatur causa hujusmodi declinationis[3]. Veruntamen causa illa non exurgit ad formam aliquam proprie, sed tantum ad *latentem processum* ad [formam[4]. Qui enim vias naturae noverit, is *deviationes* etiam facilius

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[1] An instance of the former case is to be found in the English word 'strap,' of the latter in the German word 'schwarz.'

[2] Mr. Kitchin truly remarks that 'Instances 7, 8, and 9 might have all come under one head, for *Mono[a]dicae* in Species are what *Deviantes* are in Individuals, and *Limitaneae* are offshoots of *Mono[a]dicae*, being those cases in which two species seem to have transgressed one another's limits.' Saturn's rings, the perturbations of the planet Uranus, and the red flames which accompany a total eclipse of the Sun would fall under the head of Instantiae Deviantes.

[3] An admirable instance of an enquiry of this kind is that which led to the discovery of the planet Neptune, in consequence of the observed perturbations of Uranus.

[4] The meaning of this remark is not very obvious. For a true explanation of these 'monstra' ought to throw light on the nature of the species to which they belong. What Bacon had in mind probably was that 'deviating instances' are due to some arrest or modification of the process which would ordinarily result in the more usual form, and, hence, that their explanation throws light, not directly on the form, but on the process which leads to the form. Indirectly, however, it would illustrate the nature or form as well.

observabit. At rursus, qui *deviationes* noverit, is accuratius vias describet[5].

Atque in illo differunt etiam ab *instantiis monodicis*, quod multo magis instruant praxin et operativam. Nam novas species generare arduum admodum foret; at species notas variare, et inde rara multa ac inusitata producere, minus arduum[6]. Facilis autem transitus est a miraculis naturae ad miracula artis[7]. Si enim deprehendatur semel natura in variatione sua, ejusque ratio manifesta fuerit, expeditum erit eo deducere naturam per artem quo per casum aberraverit. Neque solum eo, sed et aliorsum; cum errores ex una parte monstrent et aperiant viam ad errores et deflexiones undequaque. Hic vero exemplis non est opus, propter eorundem copiam. Facienda enim est congeries sive historia naturalis particularis omnium monstrorum et partuum naturae prodigiosorum; omnis denique novitatis et raritatis et inconsueti in natura[8]. Hoc vero faciendum est cum severissimo delectu, ut constet fides. Maxime autem habenda sunt pro suspectis quae pendent quomodocunque a religione, ut prodigia Livii: nec minus, quae inveniuntur in scriptoribus magiae naturalis, aut etiam alchymiae, et hujusmodi hominibus; qui tanquam proci sunt et amatores fabularum. Sed depromenda sunt illa ex gravi et fida historia, et auditionibus certis.

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[5] The truth of these words is obvious, but the maxim is none the less important, and affords a happy example of Bacon's sagacity as well as his felicity of expression.

[6] Familiar illustrations of this artificial process of variation are supplied by the cases of plants, dogs, pigeons, cattle, &c.

What man does, in comparatively brief periods of time, in the case of varieties, Mr. Darwin has shown that Nature probably does, throughout the lapse of long ages, in the case of species and even the higher classes.

[7] Καὶ τρόπον τινὰ περὶ τὰ αὐτά ἐστιν ἡ τύχη καὶ ἡ τέχνη, καθάπερ καὶ Ἀγάθων φησὶ

τέχνη τύχην ἔστερξε καὶ τύχη τέχνην.

Eth. Nic. vi. 4 (5).

A wonderful instance of the successful imitation of Nature by Art is the artificial production of marble, through fusion under violent pressure, by Sir James Hall, to which I have already referred (p. 344).

[8] Such are many of the 'experiments' in the Sylva Sylvarum.

XXX.

Inter *praerogativas instantiarum*, ponemus loco nono *Instantias Limitaneas*[9]; quas etiam *Participia* vocare consuevimus. Eae vero sunt, quae exhibent species corporum tales, quae videntur esse compositae ex speciebus duabus, vel rudimenta inter speciem unam et alteram. Hae vero instantiae inter *instantias monodicas* sive *heteroclitas* recte numerari possunt: sunt enim in universitate rerum rarae et extraordinariae. Sed tamen ob dignitatem seorsim tractandae et ponendae sunt; optime enim indicant compositionem et fabricam rerum, et innuunt causas numeri et qualitatis specierum ordinariarum in universo, et deducunt intellectum ab eo quod est, ad id quod esse potest[10].

Harum exempla sunt: muscus, inter putredinem et plantam; cometae nonnulli, inter stellas et meteora ignita[11]; pisces volantes, inter aves et pisces; vespertiliones, inter aves et quadrupedes; etiam

'Simia quam similis turpissima bestia nobis[12];'

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[9] 'These Limiting Instances or "participia," (i. e. partakers of two or more kinds, just as the Participle in Grammar participates in the nature of Verb and Noun,) exhibit a combination of two kinds, and so seem to stand between the Singular and the Deviating instances. Bacon's examples are not satisfactory. Moss is by no means "inter putredinem et plantam." Some of the Zoophytes, or the Ornithorhyncus Paradoxus would be better examples. Neither Flying-fish nor Bats are "limiting" between two kinds, except in appearance.' Mr. Kitchin's note. The bat belongs to the Order of Cheiroptera in the Class Mammalia, though vulgarly supposed to be an abnormal sort of bird. The flying-fish, also, has no structural resemblance to a bird.

Professor Rolleston has suggested to me that the best example in the animal world of the 'instantiae limitaneae' is the order Dipnoi, including the three species, Lepidosiren Paradoxa, Lepidosiren Annectens, and Keratodus. These animals have affinities to fishes in one set of organs, and to amphibia in another.

[10] The language of this paragraph seems almost to anticipate the theories of Evolution maintained by recent Naturalists. Cp. i. 66, and the last Aphorism.

[11] Stars are seen in the heavens permanently; meteors only momentarily. Comets are seen for some time, and then disappear. This must have been the ground on which Bacon referred them to the 'Instantiae limitaneae.'

[12] Quoted from Ennius by Cicero, De Natura Deorum, i. 35.

et partus animalium biformes et commisti ex speciebus diversis; et similia.

XXXI.

Inter *praerogativas instantiarum* ponemus decimo loco *Instantias Potestatis*, sive *Fascium*[13] (sumpto vocabulo ab insignibus imperii), quas etiam *Ingenia*, sive *Manus Hominis* appellare consuevimus. Eae sunt opera maxime nobilia et perfecta, et tanquam ultima in unaquaque arte. Cum enim hoc agatur praecipue ut natura pareat rebus et commodis humanis; consentaneum est prorsus, ut opera, quae jampridem in potestate hominis fuerunt (quasi provinciae antea occupatae et subactae), notentur et numerentur; praesertim ea quae sunt maxime enucleata et perfecta: propterea quod ab istis proclivior et magis in propinquo sit transitus ad nova et hactenus non inventa. Si quis enim ab horum contemplatione attenta propositum acriter et strenue urgere velit, fiet certe ut aut producat illa paulo longius, aut deflectat illa ad aliquid quod finitimum est, aut etiam applicet et transferat illa ad usum aliquem nobiliorem.

Neque hic finis. Verum quemadmodum ab operibus naturae raris et inconsuetis erigitur intellectus et elevatur ad inquirendas et inveniendas formas, quae etiam illorum sunt capaces[14], ita etiam in operibus artis egregiis et admirandis hoc usu-venit; idque multo magis; quia modus efficiendi et operandi hujusmodi miracula artis manifestus ut plurimum est, cum plerunque in miraculis naturae sit magis obscurus. Attamen in his ipsis cautio est adhibenda vel maxime, ne deprimant scilicet intellectum et eum quasi humo affigant.

Periculum enim est, ne per hujusmodi opera artis, quae videntur velut summitates quaedam et fastigia industriae

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[13] These instances are evidences of man's power, being 'the most noble and perfect and, as it were, consummate productions in each art.' It would be endless to adduce recent examples, such as the steam engine, with its many applications, the electric telegraph, chloroform, photography, &c.

[14] 'Which are capable of including them also.' He means that the study of these rare and unusual works of nature leads to a knowledge of the Forms, which they exemplify in a more or less peculiar manner.

humanae, reddatur intellectus attonitus et ligatus et quasi maleficiatus quoad illa, ita ut cum aliis consuescere non possit, sed cogitet nihil ejus generis fieri posse nisi eadem via qua illa effecta sunt, accedente tantummodo diligentia majore et praeparatione magis accurata[15].

Contra, illud ponendum est pro certo: vias et modos efficiendi res et opera, quae adhuc reperta sunt et notata, res esse plerunque pauperculas; atque omnem potentiam majorem pendere et ordine derivari a fontibus formarum, quarum nulla adhuc inventa est[16].

Itaque (ut alibi diximus[17]) qui de machinis et arietibus, quales erant apud veteres, cogitasset, licet hoc fecisset obnixe atque aetatem in eo consumpsisset, nunquam tamen incidisset in inventum tormentorum igneorum operantium per pulverem pyrium. Neque rursus, qui in lanificiis et serico vegetabili observationem suam et meditationem collocasset, unquam per ea reperisset naturam vermis aut serici bombycini.

Quocirca omnia inventa, quae censeri possunt magis nobilia (si animum advertas), in lucem prodiere, nullo modo per pusillas enucleationes et extensiones artium, sed omnino per casum. Nihil autem repraesentat[18] aut anticipat casum (cujus mos est ut tantum per longa saecula operetur), praeter inventionem formarum[19].

Exempla autem hujusmodi instantiarum particularia nihil opus est adducere, propter copiam eorundem. Nam hoc omnino agendum; ut visitentur et penitus introspiciantur omnes artes mechanicae, atque liberales etiam (quatenus ad

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[15] Cp. i. 6, 85.

[16] Cp. i. 75, ii. 2, 17. De Augmentis, iii. 4 (E. and S., vol. i. pp. 564–566).

[17] See i. 109.

[18] See note on this word at the end of i. 109.

[19] Cp. ii. 3 ad fin.: 'At qui formas novit, is naturae unitatem in materiis dissimillimis complectitur; itaque quae adhuc facta non sunt, qualia nec naturae vicissitudines, neque experimentales industriae, neque casus ipse, in actum unquam perduxissent, neque cogitationem humanam subitura fuissent, detegere et producere potest. Quare ex formarum inventione sequitur contemplatio vera, et operatio libera.'

opera), atque inde facienda est congeries sive historia particularis, tanquam magnalium et operum magistralium et maxime perfectorum in unaquaque ipsarum, una cum modis effectionis sive operationis.

Neque tamen astringimus diligentiam, quae adhibenda est in hujusmodi collecta, ad ea quae censentur pro magisteriis et arcanis alicujus artis tantum, atque movent admirationem. Admiratio enim proles est raritatis; siquidem rara, licet in genere sint ex vulgatis naturis, tamen admirationem pariunt.

At contra, quae revera admirationi esse debent propter discrepantiam quae inest illis in specie collatis ad alias species, tamen si in usu familiari praesto sint leviter notantur. Debent autem notari *monodica* artis, non minus quam *monodica* naturae; de quibus antea diximus[20]. Atque quemadmodum in *monodicis* naturae posuimus solem, lunam, magnetem, et similia, quae re vulgatissima sunt sed natura tamen fere singulari: idem et de *monodicis* artis faciendum est.

Exempli gratia; instantia *monodica* artis est papyrus; res admodum vulgata. At si diligenter animum advertas, materiae artificiales aut plane textiles sunt per fila directa et transversa; qualia sunt pannus sericus, aut laneus, et linteus, et hujusmodi: aut coagmentantur ex succis concretis; qualia sunt later, aut argilla figularis, aut vitrum, aut esmalta[21], aut porcellana, et similia; quae si bene uniantur splendent, sin minus, indurantur certe, sed non splendent. Attamen omnia talia, quae fiunt ex succis concretis, sunt fragilia, nec ullo modo haerentia et tenacia. At contra, papyrus est corpus tenax, quod scindi et lacerari possit; ita ut imitetur et fere aemuletur pellem sive membranam alicujus animalis, aut folium alicujus vegetabilis, et hujusmodi opificia naturae. Nam neque fragilis est, ut vitrum; neque textilis, ut pannus; sed habet fibras certe, non fila distincta, omnino ad modum materiarum naturalium: ut inter artificiales materias vix inveniatur simile aliquod, sed sit plane *monodicum*[22]. Atque

[20] Aph. 28.

[21] 'Italian "smalto," "ismalto," enamel. The word is connected with the Anglo-Saxon "Myltan," to melt or smelt.' Mr. Kitchin's note.

[22] Mr. Ellis says: 'It is curious that Bacon should not have remarked that all the qualities here mentioned belong to felt as well as to paper.'

praeferenda sane sunt in artificialibus ea quae maxime accedunt ad imitationem naturae, aut e contrario eam potenter regunt et invertunt[23].

Rursus, inter *ingenia* et *manus hominis*, non prorsus contemnenda sunt praestigiae et jocularia[24]. Nonnulla enim ex istis, licet sint usu levia et ludicra, tamen informatione valida esse possunt.

Postremo, neque omnino omittenda sunt superstitiosa, et (prout vocabulum sensu vulgari accipitur) magica. Licet enim hujusmodi res sint in immensum obrutae grandi mole mendaciorum et fabularum, tamen inspiciendum paulisper si forte subsit et lateat in aliquibus earum aliqua operatio naturalis; ut in fascino, et fortificatione imaginationis, et consensu rerum ad distans, et transmissione impressionum a spiritu ad spiritum non minus quam a corpore ad corpus, et similibus[25].

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[23] Of this last class the lightning-conductor is an admirable example.

[24] The remark is perfectly just. Numbers of toys and tricks illustrate scientific principles, as well as mental habitudes.

In the Catalogus Historiarum Particularium, published at the end of the First Edition of the Novum Organum, are enumerated, '123, Historia Ludorum omnis generis; 124, Historia Praestigiatorum et Circulatorum.'

[25] Cp. De Augmentis, lib. iv. cap. 3 (E. and S., vol. i. pp. 608, 609), Sylva Sylvarum, Century X. (E. and S., vol. ii. p. 640, &c.). In Exp. 986, he relates the story of the dream which he had at Paris two or three days before his father's death.

This class of questions had an irresistible attraction for the men of Bacon's time, nor have they ceased to be discussed with interest by many scientific men even in our own.

Of the extravagant lengths to which the belief in the 'consensus rerum ad distans' and the 'transmissio impressionum' were sometimes carried, we have some very amusing instances in Dr. Glanvill's Scepsis Scientifica, a work published in 1665, forty-five years after the publication of the Novum Organum. I select two of these, and feel confident that the reader will require no apology for their length:

'Besides this' (sc. conference by means of sympathetic dials) 'there is another way of Secret Conveyance that's whisper'd about the World, the *truth* of which I vouch not, but the *possibility*: it is conference at distance by sympathized hands. For say the relatours of this strange secret: The hands of two friends being allyed by the transferring of Flesh from one into another, and the place of the Letters mutually agreed on; the least prick in the hand of one, the other will be sensible of, and that in the same part of his own. And thus the distant friend, by a new kind of

XXXII.

Ex iis, quae ante dicta sunt, patet quod quinque illa instantiarum genera de quibus diximus (viz. *instantiarum conformium*, *instantiarum monodicarum*, *instantiarum deviantium*, *instantiarum limitanearum*, *instantiarum potestatis*) non debeant reservari, donec inquiratur natura aliqua certa (quemadmodum instantiae reliquae, quas primo loco proposuimus, nec non plurimae ex iis quae sequentur, reservari debent); sed statim jam ab initio facienda est earum collectio, tanquam historia quaedam particularis; eo quod digerant ea quae ingrediuntur intellectum, et corrigant pravam complexionem intellectus ipsius, quem omnino necesse est imbui et infici et demum perverti ac distorqueri ab incursibus quotidianis et consuetis [26].

Chiromancy, may read in his own hand what his correspondent had set down in his. For instance, would I in London acquaint my intimate in Paris, that *I am well:* I would then prick that part where I had appointed the letter [I] and, doing so in another place to signifie that word was done, proceed to [A] thence to [M] and so on, till I had finisht what I intended to make known.'

'Then there is a Magnetick way of curing wounds by anointing the weapon, and that the wound is affected in like manner as is the extravenate blood by the Sympathetick medicine, as to matter of fact is with circumstances of good evidence asserted by the Noble Sir K. Digby in his ingenious discourse on the subject. The reason of this magnale he attempts by Mechanism, and endeavours to make it out by atomical aporrheas, which passing from the cruentate cloth or weapon to the wound, and being incorporated with the particles of the salve carry them in their embraces to the affected part: where the medicinal atomes entering together with the effluviums of the blood, do by their subtle insinuation better effect the cure, than can be done by any grosser application. The particular way of their conveyance, and their regular direction is handsomely explicated by that learned Knight, and recommended to the ingenious by most witty and becoming illustrations. It is out of my way here to enquire whether the Anima Mundi be not a better account than any Mechanical Solutions. The former is more desperate; the latter perhaps hath more of ingenuity than good ground of satisfaction. It is enough for me that *de facto* there is such an entercourse between the Magnetick unguent and the vulnerated body, and I need not be solicitous of the cause.'

[26] These five instances are regarded rather as furnishing materials for a Natural History, and as instrumental in removing prejudices, than as directly suggesting inductive inferences. But, as Mr. Kitchin says, it

Itaque adhibendae sunt eae instantiae tanquam praeparativum aliquod, ad rectificandum et expurgandum intellectum. Quicquid enim abducit intellectum a consuetis, aequat et complanat aream ejus ad recipiendum lumen siccum et purum notionum verarum.

Quin etiam hujusmodi instantiae sternunt et praestruunt viam ad operativam; ut suo loco dicemus, quando de *Deductionibus ad Praxin*[27] sermo erit.

XXXIII.

Inter *praerogativas instantiarum* ponemus loco undecimo *Instantias Comitatus*, atque *Hostiles*[28]; quas etiam *Instantias Propositionum Fixarum* appellare consuevimus. Eae sunt instantiae, quae exhibent aliquod corpus sive concretum tale, in quo natura inquisita perpetuo sequatur tanquam comes quidam individuus: aut contra, in quo natura inquisita perpetuo fugiat atque ex comitatu excludatur, ut hostis et inimicus. Nam ex hujusmodi instantiis formantur propositiones certae et universales, aut *affirmativae* aut *negativae;* in quibus subjectum erit tale corpus in concreto, praedicatum vero natura ipsa inquisita. Etenim propositiones particulares omnino *fixae* non sunt, ubi scilicet natura inquisita reperitur in aliquo concreto fluxa et mobilis, viz. accedens sive acquisita, aut rursus recedens sive deposita. Quocirca particulares propositiones non habent *praerogativam* aliquam majorem, nisi tantum in casu *migrationis;* de quo antea dictum est. Et nihilominus, etiam particulares illae propositiones comparatae et collatae cum universalibus multum juvant; ut suo loco dicetur[29]. Neque tamen, etiam in universalibus istis propositionibus exactam aut absolutam affirmationem vel abnegationem requirimus. Sufficit enim ad id quod

is hard to see why, if they are merely preliminary, they should be inserted in this place.

[27] The seventh in order of the 'reliqua auxilia intellectus' (see Aph. 21). This part of the Novum Organum Bacon never reached.

[28] These instances are such as the nature in question is constantly associated with, or constantly dissociated from. The fact is expressed, in the one case, by an Universal Affirmative, and, in the other, by an Universal Negative Proposition. In both cases, the instance furnishes the subject of the proposition, and the nature in question the predicate.

[29] He alludes to the Instantiae Subjunctivae of the next Aphorism.

agitur, etiamsi exceptionem nonnullam singularem aut raram patiantur[30].

Usus autem *instantiarum comitatus* est ad angustiandam *affirmativam* formae. Quemadmodum enim in *instantiis migrantibus* angustiatur *affirmativa* formae; viz. ut necessario poni debeat forma rei esse aliquid quod per actum illum *migrationis* inditur aut destruitur; ita etiam in *instantiis comitatus* angustiatur *affirmativa* formae; ut necessario poni debeat forma rei esse aliquid quod talem concretionem corporis subingrediatur, aut contra ab eadem abhorreat; ut qui bene norit constitutionem aut schematismum hujusmodi corporis non longe abfuerit ab extrahenda in lucem forma naturae inquisitae[31].

Exempli gratia; sit natura inquisita Calidum. *Instantia comitatus* est flamma[32]. Etenim in aqua, aëre, lapide, metallo, et aliis quamplurimis, calor est mobilis, et accedere potest et recedere: at omnis flamma est calida, ita ut calor in concretione flammae perpetuo sequatur. At *instantia hostilis* calidi nulla reperitur apud nos. Nam de visceribus terrae nihil constat ad sensum; sed eorum corporum quae nobis nota sunt nulla prorsus est concretio quae non est susceptibilis caloris[33].

At rursus, sit natura inquisita Consistens. *Instantia hostilis* est aër. Etenim metallum potest fluere, potest consistere;

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[30] But this exception must always be regarded as requiring explanation. The history of science is rich in explanations of this kind.

[31] Thus, if the form required be that of heat, and we have observed that heat always accompanies flame, the 'form' or nature of heat may be detected by a careful examination of flame. Similarly, if the form required be that of transparency, and we have observed that malleability never accompanies transparency, the 'form' or nature of transparency must be something which is not to be found in malleable substances (or, at least, something which, if it is to be found in them, is counteracted by other properties). It is plain from the qualification, just given, how liable to error may be reasoning based solely on 'instantiae hostiles.'

[32] Not only is flame always accompanied by heat, but, as Professor Playfair adds, 'the same degree of heat in a given substance is always accompanied with flame,' that is to say, there is always a given temperature at which any particular incandescent substance bursts into flame.

[33] This passage again shews Bacon's ignorance of the purely relative character of the expressions 'Hot' and 'Cold.'

similiter vitrum; etiam aqua potest consistere, cum conglaciatur: at impossibile est ut aër unquam consistat, aut exuat fluorem[34].

Verum de *instantiis* hujusmodi *propositionum fixarum* supersunt duo monita, quae utilia sunt ad id quod agitur. Primum, ut si defuerit plane universalis *affirmativa* aut *negativa*, illud ipsum diligenter notetur tanquam non-ens[35]; sicut fecimus de calido, ubi universalis negativa (quatenus ad entia quae ad nostram notitiam pervenerint) in rerum natura deest. Similiter, si natura inquisita sit aeternum aut incorruptibile, deest affirmativa universalis hic apud nos. Neque enim praedicari potest *Aeternum* aut *Incorruptibile* de aliquo corpore eorum quae infra coelestia sunt, aut supra interiora terrae[36]. Alterum monitum est, ut propositionibus universalibus, tam affirmativis quam negativis, de aliquo concreto, subjungantur[37] simul ea

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[34] This was the opinion of scientific men even long after Bacon's time, and it is repeated, though in rather more cautious language, by Professor Playfair. But, as I have already pointed out, analogy leads us to conclude that all aeriform fluids admit, if their temperature were sufficiently reduced, of being converted, first into liquids, and then into solids. In fact, it is now stated that this result has actually been achieved even in the case of oxygen, hydrogen, and nitrogen. See Academy of Jan. 12, 1878, or Nature of Jan. 3 and 17.

[35] Though expressed in scholastic language, the meaning of this caution is plain. If we are unable to establish an universal affirmative or an universal negative, the mere fact of such incapacity is worth the noting.

[36] In the Descriptio Globi Intellectualis (E. and S., vol. iii. pp. 754–7) Bacon criticises severely the dogma of Aristotle and the Peripatetics, which affirms the immutability of the heavenly bodies. The same passage shews why he here brings the 'interiora terrae' into juxtaposition with 'coelestia.' 'Deinde si quis adhuc instet, negari tamen non posse quin in ipsa superficie orbis terrarum et partibus proximis infinitae fiant mutationes, in coelo non item; huic ita occurrimus; nec nos haec per omnia aequare, et tamen si regiones (quas vocant) superiorem et mediam aëris pro superficie aut interiore tunica coeli accipiamus, quemadmodum spatium istud apud nos, quo animalia, plantae, et mineralia continentur, pro superficie vel exteriore tunica terrae accipimus; et ibi quoque varias et multiformes generationes inveniri. Itaque tumultus fere omnis et conflictus et perturbatio in confiniis tantum coeli et terrae locum habere videtur; ut in rebus civilibus fit, in quibus illud frequenter usu venit, ut duorum regnorum fines continuis incursionibus et violentiis infestentur, dum interiores utriusque regni provinciae diutina pace fruuntur, et bellis tantum gravioribus et rarioribus commoventur.'

[37] See next Aphorism.

concreta quae proxime videntur accedere ad id quod est ex non-entibus[38]: ut in calore, flammae mollissimae et minimum adurentes; in incorruptibili, aurum, quod proxime accedit. Omnia enim ista indicant terminos naturae inter ens et non-ens; et faciunt ad circumscriptiones formarum, ne gliscant et vagentur extra conditiones materiae[39].

XXXIV.

Inter praerogativas instantiarum, ponemus loco duodecimo ipsas illas *Instantias Subjunctivas*, de quibus in superiori aphorismo diximus: quas etiam *Instantias Ultimitatis* sive *Termini* appellare consuevimus. Neque enim hujusmodi instantiae utiles sunt tantum, quatenus subjunguntur propositionibus fixis; verum etiam per se, et in proprietate sua[40]. Indicant enim non obscure veras sectiones naturae, et mensuras rerum, et illud *Quousque* natura quid faciat et ferat, et deinde transitus naturae ad aliud. Talia sunt, aurum, in pondere[41]; ferrum, in duritie; cete, in quantitate animalium; canis, in odore; inflammatio pulveris pyrii, in expansione celeri; et alia id genus. Nec minus exhibenda sunt ea quae sunt ultima gradu infimo, quam quae supremo: ut spiritus vini, in pondere; sericum, in mollitie; vermiculi cutis[42], in quantitate animalium; et caetera.

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[38] Or, as we should say, which least exemplify the given proposition.

[39] He appears here to regard matter as limiting and checking the exhibition of the form. Hence, in certain cases, he conceives, the manifestation of the form is weak; and we must take care to state our general propositions, whether affirmative or negative, with due qualifications.

[40] Except in relation to the Instances described in the last Aphorism, it is difficult to see how this class of instances constitutes a distinct division. Surely, when regarded in themselves, out of relation to the others, they are merely the 'Glaring Instances' and 'Clandestine Instances' over again.

[41] Platinum is heavier than gold, ether is lighter than spirits of wine; the diamond is harder than iron; some detonating powders exceed gunpowder in their expansive force; and the whale, though larger than any other living animal, must yield to the geological monsters which the researches of recent geologists and anatomists have re-constructed for us.

[42] The 'Vermiculi cutis' (to which Bacon refers again in Aph. 43) are, as Mr. Kitchin observes, 'not animal bodies, but only little vessels caused originally by the obstruction of the glands placed immediately under the

XXXV.

Inter *praerogativas instantiarum*, ponemus loco decimo tertio *Instantias Foederis* sive *Unionis*[43]. Eae sunt, quae confundunt et adunant naturas, quae existimantur esse heterogeneae, et pro talibus notantur et signantur per divisiones receptas.

At *instantiae foederis* ostendunt operationes et effectus, quae deputantur alicui ex illis heterogeneis ut propria, competere etiam aliis ex heterogeneis; ut convincatur ista heterogenia (quae in opinione est) vera non esse aut essentialis, sed nil aliud esse quam modificatio naturae communis. Optimi itaque sunt usus ad elevandum et evehendum intellectum a differentiis ad genera; et ad tollendum larvas et simulachra rerum, prout occurrunt et prodeunt personatae in substantiis concretis.

Exempli gratia: sit natura inquisita Calidum. Omnino videtur esse divisio solennis et authentica, quod sint tria genera caloris; viz. calor coelestium, calor animalium, et calor ignis[44]; quodque isti calores (praesertim unus ex illis comparatus ad reliquos duos) sint ipsa essentia et specie, sive natura specifica, differentes et plane heterogenei: quandoquidem calor coelestium et animalium generet et foveat, at calor ignis contra corrumpat et destruat[45]. Est itaque *instantia foederis*

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skin, from which a minute pipe carries off the perspiration.' Professor Rolleston informs me that there is a minute microscopic animal, called Demodex folliculorum, discovered by a German physician, Dr. Simon, in the unctuous matter which collects within the oil-tubes of the skin. But, of course, Bacon could have had no means of observing it.

[43] An instance of Alliance is an instance which exhibits the identity or similarity of natures which are supposed to be heterogeneous, and thus leads from the consideration of the differentiae to that of the genus.

An excellent example would be the fall of detached bodies to the earth, which is said to have suggested to Newton that there was a common explanation of terrestrial gravitation and of the force which retains the planets in their orbits.

[44] This is, even still, a vulgar division of the different kinds of heat. Telesius had anticipated Bacon in criticising it. See De Rerum Natura, vi. 20, a passage which Bacon had evidently read.

[45] See Aristotle, De Generatione Animalium, ii. 3 (Berlin Ed., p. 737 a. 1, κ. τ. λ.): *διὸ πῦρ μὲν οὐθὲν γεννᾷ ζῷον, οὐδὲ φαίνεται συνιστάμενον πυρουμένοις οὔτ᾽ ἐν ὑγροῖς οὔτ᾽ ἐν ξηροῖς οὐθέν· ἡ δὲ τοῦ ἡλίου θερμότης καὶ ἡ τῶν ζῴων οὐ μόνον ἡ διὰ τοῦ σπέρματος, ἀλλὰ κἄν τι περίττωμα τύχῃ τῆς φύσεως ὂν*

experimentum illud satis vulgatum, cum recipitur ramus aliquis vitis intra domum ubi sit focus assiduus, ex quo maturescunt uvae etiam mense integro citius quam foras; ita ut maturatio fructus etiam pendentis super arborem fieri possit, scilicet ab igne, cum hoc ipsum videatur esse opus proprium solis[46]. Itaque ab hoc initio facile insurgit intellectus, repudiata heterogenia essentiali, ad inquirendum quae sint differentiae illae quae revera reperiuntur inter calorem solis et ignis, ex quibus fit ut eorum operationes sint tam dissimiles, utcunque illi ipsi participent ex natura communi.

Quae differentiae reperientur quatuor: viz. primo, quod calor solis respectu caloris ignis sit gradu longe clementior et lenior; secundo, quod sit (praesertim ut defertur ad nos per aërem) qualitate multo humidior; tertio (quod caput rei est), quod sit summe inaequalis, atque accedens et auctus, et deinceps recedens et diminutus; id quod maxime confert ad generationem

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ἕτερον, ὅμως ἔχει καὶ τοῦτο ζωτικὴν ἀρχήν. ὅτι μὲν οὖν ἡ ἐν τοῖς ζῴοις θερμότης οὔτε πῦρ οὔτε ἀπὸ πυρὸς ἔχει τὴν ἀρχήν, ἐκ τῶν τοιούτων ἐστὶ φανερόν.

[46] 'The regular use of artificial heat in green-houses and conservatories was not known in Bacon's time. In the *Maison Champêtre*, an encyclopaedia of gardening and agriculture published in 1607, nothing is said of it; nor is there anything on the subject in the writings of Porta, though in his *Nat. Mag.* he has spoken of various modes of accelerating the growth of fruits and flowers. In the *Sylva Sylvarum* (412), however, Bacon speaks of housing hot-country plants to save them, and, in the *Essay on Gardens*, of stoving myrtles. The idea of what are now called green-houses was introduced into England from Holland about the time of the Revolution. The orangery at Heidelberg, formed, I believe, about the middle of the seventeenth century, is said to be the earliest conservatory on record.

'It is related that Albertus Magnus, entertaining the emperor at Cologne during the winter, selected for the place of entertainment the garden of his monastery. Everything was covered with snow, and the guests were much inclined to be discontented; but when the feast began, the snow cleared away; the trees put forth, first leaves, then blossoms, then fruit; and the climate became that of summer. This glorious summer, which had thus abruptly succeeded to the winter of their discontent, lasted only to the conclusion of the feast, when everything resumed its former aspect. It would be a fanciful explanation, and I know not whether it has ever been suggested, to say that Albertus Magnus really entertained the emperor in a conservatory, and only led his guests through the garden. See, for the story, Grimm's *Deutsche Sagen*.' Mr. Ellis' note.

corporum. Recte enim asseruit Aristoteles[47] causam principalem generationum et corruptionum, quae fiunt hic apud nos in superficie terrae, esse viam obliquam solis per zodiacum[48]; unde calor solis, partim per vicissitudines diei et noctis, partim per successiones aestatis et hyemis, evadit miris modis inaequalis. Neque tamen desinit ille vir id quod ab eo recte inventum fuit statim corrumpere et depravare. Nam ut arbiter scilicet naturae (quod illi in more est) valde magistraliter assignat causam generationis accessui solis, causam autem corruptionis recessui; cum utraque res (accessus videlicet solis et recessus) non respective, sed quasi indifferenter, praebeat causam tam generationi quam corruptioni; quandoquidem inaequalitas caloris generationi et corruptioni rerum, aequalitas conservationi tantum ministret. Est et quarta differentia inter calorem solis et ignis, magni prorsus momenti: viz. quod sol operationes suas insinuet per longa temporis spatia, ubi operationes ignis (urgente hominum impatientia) per breviora intervalla ad exitum perducantur. Quod si quis id sedulo agat, ut calorem ignis attemperet et reducat ad gradum moderatiorem et leniorem (quod multis modis facile fit), deinde etiam inspergat et admisceat nonnullam humiditatem, maxime autem si imitetur calorem solis in inaequalitate, postremo si moram patienter toleret (non certe eam quae sit proportionata operibus solis, sed largiorem quam homines adhibere solent in operibus ignis), is facile missam faciet heterogeniam illam caloris, et vel tentabit vel exaequabit vel in aliquibus vincet opera solis, per calorem ignis. Similis *instantia foederis* est resuscitatio papilionum ex frigore stupentium

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[47] Meteorologica, i. 14 (p. 351 a): *τῇ δὲ γῇ τοῦτο* (sc. *ἀκμὴν ἔχειν καὶ γῆρας*) *γίγνεται κατὰ μέρος διὰ ψύξιν καὶ θερμότητα. Ταῦτα μὲν οὖν αὔξεται καὶ φθίνει διὰ τὸν ἥλιον καὶ τὴν περιφοράν, διὰ δὲ ταῦτα καὶ τὴν δύναμιν τὰ μέρη τῆς γῆς λαμβάνει διαφέρουσαν, ὥστε μέχρι τινὸς ἔνυδρα δύναται διαμένειν, εἶτα ξηραίνεται καὶ γηράσκει πάλιν· ἕτεροι δὲ τόποι βιώσκονται καὶ ἔνυδροι γίγνονται κατὰ μέρος.*

De Generatione et Corruptione, ii. 10 (p. 336 a, b). It is to this latter passage that the words 'Nam ut arbiter' &c. refer. See 336 b. 17, &c.: *ὁρῶμεν γὰρ ὅτι προσιόντος μὲν τοῦ ἡλίου γένεσίς ἐστιν, ἀπιόντος δὲ φθίσις, καὶ ἐν ἴσῳ χρόνῳ ἑκάτερον· ἴσος γὰρ ὁ χρόνος τῆς φθορᾶς καὶ τῆς γενέσεως τῆς κατὰ φύσιν.*

[48] *ἡ κατὰ τὸν λοξὸν κύκλον φορά.* De Gen. et Corr. ii. 10.

et tanquam emortuarum, per exiguum teporem ignis; ut facile cernas non magis negatum esse igni vivificare animantia quam maturare vegetabilia. Etiam inventum illud celebre Fracastorii[49] de sartagine acriter calefacta, qua circundant medici capita apoplecticorum desperatorum, expandit manifeste spiritus animales ab humoribus et obstructionibus cerebri compressos et quasi extinctos, illosque ad motum excitat, non aliter quam ignis operatur in aquam aut aërem, et tamen per consequens vivificat. Etiam ova aliquando excluduntur per calorem ignis, id quod prorsus imitatur calorem animalem; et complura ejusmodi; ut nemo dubitare possit quin calor ignis in multis subjectis modificari possit ad imaginem caloris coelestium et animalium.

Similiter sint naturae inquisitae Motus et Quies. Videtur esse divisio solennis atque ex intima philosophia, quod corpora naturalia vel rotent, vel ferantur recta, vel stent sive quiescant. Aut enim est motus sine termino, aut statio in termino, aut latio ad terminum. At motus ille perennis rotationis videtur esse coelestium proprius; statio sive quies videtur competere globo ipsi terrae; at corpora caetera (gravia quae vocant et levia, extra loca scilicet connaturalitatis suae sita) feruntur recta ad massas sive congregationes similium; levia sursum, versus ambitum coeli; gravia deorsum, versus terram. Atque ista pulchra dictu sunt[50].

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[49] It is related of this distinguished physician (born at Verona 1483, died 1553) that, apoplexy having deprived him of the use of speech, he made a sign to his servants to apply cupping-glasses to his head; but, not being understood, he died in a few hours.

Cupping is effected by rarefying the air within the vessel, and thus partially removing the atmospheric pressure from the surface of the skin, which accordingly rises. This operation is generally followed by making incisions on the raised surface, by means of a scarificator.

[50] This is the ordinary Peripatetic account of what is called 'motion of translation' (φορά), and is stated almost in the words of Aristotle himself. See, amongst other places, De Coelo, i. 2 (pp. 268 b–269 b), from which I extract the following passage: Πᾶσα δὲ κίνησις ὅση κατὰ τόπον, ἣν καλοῦμεν φοράν, ἢ εὐθεῖα ἢ κύκλῳ ἢ ἐκ τούτων μικτή· ἁπλαῖ γὰρ αὗται δύο μόναι. Αἴτιον δ' ὅτι καὶ τὰ μεγέθη ταῦτα ἁπλᾶ μόνον, ἥ τ' εὐθεῖα καὶ ἡ περιφερής. Κύκλῳ μὲν οὖν ἐστὶν ἡ περὶ τὸ μέσον, εὐθεῖα δ' ἡ ἄνω καὶ κάτω. Λέγω δ' ἄνω μὲν τὴν ἀπὸ τοῦ μέσου, κάτω δὲ τὴν ἐπὶ τὸ μέσον. Ὥστ' ἀνάγκη πᾶσαν εἶναι τὴν ἁπλῆν φορὰν τὴν μὲν ἀπὸ τοῦ μέσου, τὴν δ' ἐπὶ τὸ μέσον, τὴν δὲ περὶ τὸ μέσον. The

At *instantia foederis* est cometa aliquis humilior; qui cum sit longe infra coelum, tamen rotat[51]. Atque commentum Aristotelis[52] de alligatione sive sequacitate cometae ad astrum aliquod jampridem explosum est; non tantum quia ratio ejus non est probabilis, sed propter experientiam manifestam discursus et irregularis motus cometarum per varia loca coeli.

At rursus alia *instantia foederis* circa hoc subjectum est motus aëris; qui intra tropicos (ubi circuli rotationis sunt

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other parts of the doctrine occur or are implied in the same chapter: cp. also Phys. viii. 9 (265 a, b).

It is not quite plain from Bacon's words at the end of the paragraph, whether he implicitly accepted this account, or not. From Aph. 48, 'Motus decimus septimus,' it would seem as if he did do so, whereas, in the Descriptio Globi Intellectualis (E. and S., vol. iii. pp. 754–5), he calls in question the dogmas of both the circular and the eternal motion of the heavenly bodies (cp., with regard to the former, Nov. Org. i. 45). This treatise must have been written about 1612, so that, unless we suppose that, in the two passages of the Novum Organum, he is merely stating the commonly received opinion, without thinking it necessary to criticise it, we must admit some inconsistency in his treatment of this subject.

The establishment of the true nature and laws of motion belongs to the period subsequent to Bacon, beginning with the discoveries of Galileo and ending with those of Newton. See Whewell's History of the Inductive Sciences.

[51] The comets being as much 'heavenly bodies' as the planets, this instance has, of course, no significance for us.

There is another respect, however, as Mr. Kitchin observes, in which comets afford a good example of an Instantia Foederis. Notwithstanding the apparent irregularity of their orbits, they illustrate the Law of Gravity equally with the planets, whose orbits are apparently regular, and hence their motions contribute to establish the universality of that Law.

[52] See Meteorologica, i. 7 (p. 344). It is not, however, with regard to all comets that Aristotle propounds this theory. *Ὅταν μὲν οὖν ἐν αὐτῷ τῷ κάτω τόπῳ ἡ ἀρχὴ τῆς συστάσεως ᾖ, καθ' ἑαυτὸν φαίνεται κομήτης· ὅταν δ' ὑπὸ τῶν ἄστρων τινός, ἢ τῶν ἀπλανῶν ἢ τῶν πλανήτων, ὑπὸ τῆς κινήσεως συνιστῆται ἡ ἀναθυμίασις, τότε κομήτης γίγνεται τούτων τις· οὐ γὰρ πρὸς αὐτοῖς ἡ κόμη γίγνεται τοῖς ἄστροις, ἀλλ' ὥσπερ αἱ ἅλῳ περὶ τὸν ἥλιον φαίνονται καὶ τὴν σελήνην παρακολουθοῦσαι, καίπερ μεθισταμένων τῶν ἄστρων, ὅταν οὕτως ᾖ πεπυκνωμένος ὁ ἀὴρ ὥστε τοῦτο γίγνεσθαι τὸ πάθος ὑπὸ τὴν τοῦ ἡλίου πορείαν, οὕτω καὶ ἡ κόμη τοῖς ἄστροις οἷον ἅλως ἐστίν. Πλὴν ἡ μὲν γίγνεται δι' ἀνάκλασιν τοιαύτη τὴν χρόαν, ἐκεῖ δ' ἐπ' αὐτῶν τὸ χρῶμα φαινόμενόν ἐστιν. Ὅταν μὲν οὖν κατ' ἀστέρα γένηται ἡ τοιαύτη σύγκρισις, τὴν αὐτὴν ἀνάγκη φαίνεσθαι φορὰν κινούμενον τὸν κομήτην ἥνπερ φέρεται ὁ ἀστήρ· ὅταν δὲ συστῇ καθ' αὐτόν, τότε ὑπολειπόμενοι φαίνονται.* (p. 344 a. 33–b. 11.) On Aristotle's theory of comets generally, as well as the opinions of previous philosophers, see Meteorol. i. 6, 7.

majores) videtur et ipse rotare ab oriente in occidentem[53].

Et alia rursus *instantia* foret fluxus et refluxus maris, si modo aquae ipsae deprehendantur ferri motu rotationis (licet tardo et evanido) ab oriente in occidentem; ita tamen ut bis in die repercutiantur[54]. Itaque, si haec ita se habeant, manifestum est motum istum rotationis non terminari in coelestibus, sed communicari aëri et aquae.

Etiam ista proprietas levium, nimirum ut ferantur sursum, vacillat nonnihil[55]. Atque in hoc sumi potest pro *instantia foederis* bulla aquae. Si enim aër fuerit subter aquam, ascendit rapide versus superficiem aquae, per motum illum *plagae*[56]

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[53] Bacon is alluding to the Trade-Winds, which, when not interfered with by local causes, blow, speaking roughly, from east to west. On the causes of these winds, see Herschel's Outlines of Astronomy, § 239 (4th Ed.), or Tyndall's Heat a Mode of Motion, § 206, &c. (3rd Ed.), or almost any manual of Physical Geography.

The 'circuli rotationis,' of which Bacon speaks, must be those of the winds, or of the heavens; for, in the Tractate de Fluxu et Refluxu Maris (E. and S., vol. iii. p. 53), he speaks of the theory of the earth's rotation as 'satis licenter excogitatum, quoad rationes physicas,' language which is in accordance with what he invariably says elsewhere, when the question is definitely before him. See Introduction, pp. 34, 35, and my notes there referred to.

[54] Bacon, of course, was ignorant of the true theory of the tides, namely, that they are caused by the attraction of the sun and moon, heaping up, as it were, the waters nearest to them, as well as those most remote from them. His own theory seems to have been that the waters, under the influence of the sun, move naturally from east to west, but that they are driven back by striking on the coasts of America. See his Tractate de Fluxu et Refluxu Maris, and the Introduction to it by Mr. Ellis (E. and S., vol. iii. p. 39, &c.). This idea was probably suggested by the Gulf Stream, which, under the influence of the Trade-Winds, flows, in the early part of its course, westwards, from the coast of Africa to that of America.

[55] Bacon, we must recollect, was ignorant of the true explanation of the phenomena which we designate 'light' and 'heavy.'

[56] 'Declinat, inquit, atomus. Primum cur? aliam quandam viam motus habebunt a Democrito impulsionis, quam plagam ille appellat: a te, Epicure, gravitatis et ponderis.' Cicero, De Fato, cap. 20. Δημόκριτος φύσει ἀκίνητα λέγων τὰ ἄτομα πληγῇ κινεῖσθαί φησιν. Simplic. ad Aristot. Phys. fol. 96, as quoted by Mullach. On this subject, see Mullach, Democriti Abderitae Operum Fragmenta, pp. 383–5. 'Epicurus in corporum insecabilium pondere motus naturalis principium esse voluit: contra, Democritus atomos natura sua immotas esse ratus violentum iis atque

(quam vocat Democritus), per quam aqua descendens percutit et attollit aërem sursum; non autem per contentionem aut nixum aëris ipsius. Atqui ubi ad superficiem ipsam aquae ventum fuerit, tum cohibetur aër ab ulteriore ascensu [56], per levem resistentiam quam reperit in aqua non statim tolerante se discontinuari: ita ut exilis admodum sit appetitus aëris ad superiora.

Similiter sit natura inquisita Pondus. Est plane divisio recepta, ut densa et solida ferantur versus centrum terrae, rara autem et tenuia versus ambitum coeli; tanquam ad loca sua propria. Atque loca quod attinet, (licet in scholis hujusmodi res valeant) plane inepta et puerilis cogitatio est, locum aliquid posse [57]. Itaque nugantur philosophi cum dicant quod, si perforata esset terra, corpora gravia se sisterent quando ventum

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aeternum motum attribuit, ita ut non interna vi cierentur, sed extrinsecus percussae externo pulsu agitarentur. Hujus posterioris motus, qui et ipse vibratione et vertigine fit, propria est, ni fallor, mutua impulsio ἀλληλοτυπία, ἀντιτυπία, ἀντώθησις ἡ πρὸς ἄλληλα, quam Cicero de fato cap. 20 a Democrito πληγήν nominatam esse testatur,' &c.

Bacon also refers to this 'motus *plagae*' in Nov. Org. ii. 48 (3), and in Sylva Sylvarum, Exp. 24. In the latter passage, he says: 'But as for the swift ascent of the air, while it is under the water, that is a motion of percussion from the water; which itself descending driveth up the air; and no motion of levity in the air. And this Democritus called *motus plagae*.' It is almost needless to observe that Bacon's explanation is false. The lighter particles, of course, necessarily rise to the surface, being displaced by the heavier particles which sink to the bottom.

[56] This fact is due to the force of cohesion in the particles of water, but, when that force is overcome by the efforts of the air to escape, the bubble bursts.

[57] Bacon's own theory evidently being that it is not place, but 'sympathia sive consensus cum alio corpore,' which determines the motion of light things upwards and heavy things downwards. See a striking passage, which is exactly to the point, in the beginning of the Thema Coeli (E. and S., vol. iii. p. 769): 'Videtur itaque natura rerum in dispertitione materiae, disclusisse tenuia a crassis; atque globum terrae crassis, omnia vero ab ipsa superficie terrae et aquarum ad ultima coeli usque tenuibus sive pneumaticis assignasse; tanquam geminis rerum classibus primariis, non aequis scilicet sed convenientibus portionibus. Neque vero vel aqua in nubibus haerens vel ventus in terra conclusus naturalem et propriam rerum collocationem confundit. Haec vero differentia tenuis vel pneumatici et crassi vel tangibilis omnino primordialis est, et ea qua maxime utitur *systema universi*. Sumpta autem est ex rerum conditione omnium simplicissima, hoc est copia et paucitate materiae pro exporrectione sua.'

esset ad centrum[58]. Esset enim certe virtuosum plane et efficax genus nihili, aut puncti mathematici, quod aut alia afficeret, aut rursus quod alia appeterent[59]: corpus enim non nisi a corpore patitur. Verum iste appetitus ascendendi et descendendi aut est in schematismo corporis quod movetur, aut in sympathia sive consensu cum alio corpore[60]. Quod si inveniatur aliquod corpus densum et solidum, quod nihilominus non feratur ad terram[61], confunditur hujusmodi divisio. At si recipiatur opinio Gilberti[62], quod magnetica vis terrae

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[58] While men remained ignorant of the laws of accelerating forces, this consequence was a necessary inference from the Peripatetic doctrine that heavy bodies tend downwards. It would also follow from the thesis propounded by Gilbert: 'Centrum Virtutum magneticarum in tellure, est telluris centrum.' De Magnete, lib. ii. cap. 27.

The true account is that, if a tube were bored through the centre of the earth, a body would oscillate between the point on the surface or within the tube from which it was dropped and the corresponding point on the opposite surface or within the opposite part of the tube; and, if there were no resisting medium, this oscillation would go on for ever. See Price's Infinitesimal Calculus, vol. iii. § 233. The theorem is there proved of a homogeneous sphere, but, though the earth is not homogeneous, heterogeneity on one side of the centre is approximately balanced by corresponding heterogeneity on the other, and hence the conclusion is approximately true. Taking into account, however, the influence of a resisting medium, the body would, after an enormous number of oscillations, ultimately rest at the centre.

Galileo states this case, and resolves it rightly. See Dialogo dei Massimi Sistemi, Giornata Seconda, Florence Ed. of 1842, vol. i. pp. 251–2 (Sir Thomas Salusbury's Translation, pp. 203–4).

[59] The sentence is ironical. 'For it would certainly be a very powerful and efficacious kind of nothing, or mathematical point, which could either affect other things, or again which other things might seek.'

It seems strange that Bacon did not perceive that the position which he criticises would be quite in accordance with any interpretation which could be put on the 'sympathia sive consensus' of which he speaks below, and that it would be no real exception to the rule 'corpus non nisi a corpore patitur.'

[60] Cp. Aph. 36 (3) and notes. It will be noticed that the words 'iste appetitus ascendendi et descendendi' imply the notion of positive levity.

[61] It is curious here to notice how far Bacon was from seeing that the moon was exactly a case in point, or from divining the true bond of connection ('foederis sive unionis') between its revolution round the earth and the phenomena of falling bodies.

[62] See De Magnete, lib. ii. cap. 7. The expression 'orbis virtutis,' as applied both to the earth and to ordinary magnets, is common throughout

ad alliciendum gravia non extendatur ultra orbem virtutis suae (quae operatur semper ad distantiam certam, et non ultra), hocque per aliquam instantiam verificetur; ea demum erit *instantia foederis* circa hoc subjectum [63]. Neque tamen occurrit impraesentiarum aliqua instantia super hoc certa et manifesta. Proxime videntur accedere cataractae coeli [64], quae in navigationibus per Oceanum Atlanticum versus Indias utrasque saepe conspiciuntur. Tanta enim videtur esse vis et moles aquarum quae per hujusmodi cataractas subito effunditur, ut videatur collectio aquarum fuisse ante facta, atque in his locis haesisse et mansisse; et postea potius per causam violentam dejecta et detrusa esse, quam naturali motu gravitatis cecidisse; adeo ut conjici possit, corpoream molem densam atque compactam in magna distantia a terra fore pensilem tanquam terram ipsam, nec casuram nisi dejiciatur. Verum de hoc nil certi affirmamus. Interim in hoc et in

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the book, and is defined, at the beginning, as 'totum illud spatium, per quod quaevis magnetis virtus extenditur.'

The phenomena of gravitation, it must be recollected, are explained by Gilbert as cases of magnetism.

[63] Both this and the next case, Bacon conceived, would afford examples of Instantiae Foederis, by proving that heavy bodies, though left free, may be at rest. They show how immature were his conceptions of motion, as well as of gravity.

[64] On the phenomena of Whirlwinds, Waterspouts, and Dust-Storms, see Sir John Herschel's Meteorology, pp. 241–7. After describing Whirlwinds, he says: 'They are often terminated by heavy falls of rain, a very obvious consequence of the sudden transfer of a great mass of air nearly saturated with vapour at the surface of the earth to a much higher level.' He then continues: 'Whirlwinds of this kind taking place at sea give rise to waterspouts (trombes de mer), which are very singular and sometimes dangerous phenomena. Tall columns, apparently of cloud, and reaching from the sea to the clouds, are seen moving majestically along, often several at once, sometimes straight and vertical, at others inclined and tortuous, but always, when approached, perceived to be in rapid rotation. At their bases the sea is violently agitated, and heaped up with a leaping or boiling motion. Indeed, water would seem, at least in some cases, to be actually carried up in considerable quantity, and scattered round from a great height, as solid bodies are on land. Hence they have been supposed by some to draw water from the sea by suction, a thing obviously impossible.'

It is needless to point out how crude is both Bacon's account and his explanation of these phenomena.

multis aliis facile apparebit, quam inopes simus historiae naturalis; cum loco instantiarum certarum nonnunquam suppositiones afferre pro exemplis cogamur.

Similiter sit natura inquisita Discursus Ingenii. Videtur omnino divisio vera, rationis humanae et solertiae brutorum. Attamen sunt nonnullae instantiae actionum quae eduntur a brutis, per quas videntur etiam bruta quasi syllogizare[65]: ut memoriae proditum est de corvo, qui per magnas siccitates fere enectus siti conspexit aquam in trunco cavo arboris[66]; atque cum non daretur ei intrare propter angustias, non cessavit jacere multos lapillos, per quos surgeret et ascenderet aqua ut bibere posset; quod postea cessit in proverbium.

Similiter sit natura inquisita Visibile. Videtur omnino esse divisio vera et certa, lucis, quae est visibile originale et primam copiam facit visui, et coloris, qui est visibile secundarium et sine luce non cernitur, ita ut videatur nil aliud esse quam imago aut modificatio lucis[67]. Attamen ex utraque parte circa hoc videntur esse *instantiae foederis;* scilicet, nix[68] in magna quantitate, et flamma sulphuris[69]; in quarum

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[65] The observations and speculations of Mr. Darwin, Mr. Herbert Spencer, and others, have placed in an entirely new light the comparative psychology of man and the brute animals, and shewn that here, as in the rest of nature, there is much less of discontinuity than was formerly imagined. In this, as in so many other places, Bacon seems to anticipate modern theories.

[66] In Sir Roger L'Estrange's Collection of Fables, under the head of Anianus' Fables, this story is told of 'A Crow and a Pitcher,' and the moral drawn is, 'There is a Natural Logick in Animals, over and above the Instinct of their kinds.'

[67] Mr. Ellis refers here to Telesius, De Rerum Natura, lib. vii. cap. 31, the title of the chapter being 'Non colorem, sed lucem proprium esse visus sensile.' The correspondence between his language and Bacon's is not very close, though it is quite possible that by reflecting on this and other chapters of bk. vii, Bacon's optical theories may have been suggested to him.

[68] This is not really an 'instantia foederis.' Snow, like other white bodies, reflects all the light thrown on it, and is, therefore, more easily visible than bodies which absorb part of the light; but it is not, in any sense, an independent source of light, like the sun or a flame.

[69] All flames, not merely that of sulphur, appear coloured, the particular tint depending partly on the nature and proportion of the various gases in combustion, partly on the medium through which the flame is seen.

altera videtur esse color primulum lucens, in altera lux vergens ad colorem.

XXXVI.

Inter *praerogativas instantiarum*, ponemus loco decimo quarto *Instantias Crucis*[69a]; translato vocabulo a Crucibus, quae

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Thus, flame, being both a source of light and also itself a coloured object, might properly be regarded as an 'instantia foederis.'

[69a] These are far the most celebrated of Bacon's 'Praerogativae Instantiarum.' A 'crucial instance' has become a household word in the English language, and is, perhaps, far more widely used than any other technical term of the Inductive Logic. According to the metaphor, there are two or more ways before us, and the observation or experiment in question acts as a 'guide-post' (crux) in determining us which to take. We have two or more rival hypotheses, which equally well accord with the facts hitherto observed, and then we think of some decisive experiment or observation, which, by according with one of the theories, and that only, will enable us summarily to reject the others. One of the simplest and most familiar examples is to be found in chemical processes, as where we employ a *test* for the purpose of determining the nature of a particular substance or of detecting the presence of a particular poison.

In logical classification, all crucial instances may be regarded as applications of the Method of Difference. All other circumstances being the same, the appearance or disappearance, the existence or non-existence of some one circumstance, or combination of circumstances, enables us to determine the question at issue.

A variety of examples of 'instantiae crucis' are adduced by myself in my Inductive Logic (3rd Ed., pp. 148–151), by Professor Playfair in his Preliminary Dissertation, by Sir John Herschel in his Discourse on the Study of Natural Philosophy (§§ 196, 197, 218, 246), and by Dr. Hippus in his account of the Novum Organum, published by the Society for the Diffusion of Useful Knowledge. To these I must refer the reader, as I have space for one example only, which I take from Sir John Herschel:

'The discovery of Torricelli was, however, at first much misconceived, and even disputed, till the question was finally decided by appeal to a *crucial instance*, one of the first, if not the very first on record in physics, and for which we are indebted to the celebrated Pascal. His acuteness perceived that if the weight of the incumbent air be the direct cause of the elevation of the mercury, it must be measured by the amount of that elevation, and therefore that, by carrying a barometer up a high mountain, and so ascending into the atmosphere *above* a large portion of the incumbent air, the pressure, as well as the length of the column sustained by it, must be diminished; while, on the other hand, if the phenomenon were due to the cause originally assigned, no difference could be expected to take place, whether the observation were made on a mountain or on the plain. Perhaps the decisive effect of the experiment which he caused

erectae in biviis indicant et signant viarum separationes. Has etiam *Instantias Decisorias* et *Judiciales*, et in casibus nonnullis *Instantias Oraculi* et *Mandati*, appellare consuevimus. Earum ratio talis est. Cum in inquisitione naturae alicujus intellectus ponitur tanquam in aequilibrio, ut incertus sit utri naturarum e duabus, vel quandoque pluribus, causa naturae inquisitae attribui aut assignari debeat, propter complurium naturarum concursum frequentem et ordinarium[70], *instantiae crucis* ostendunt consortium unius ex naturis (quoad naturam inquisitam) fidum et indissolubile, alterius autem varium et separabile; unde terminatur quaestio, et recipitur natura illa prior pro causa, missa altera et repudiata. Itaque hujusmodi instantiae sunt maximae lucis, et quasi magnae authoritatis; ita ut curriculum interpretationis quandoque in illas desinat,

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to be instituted for the purpose on the Puy de Dôme, a high mountain in Auvergne, while it convinced every one of the truth of Torricelli's views, tended more powerfully than any thing which had previously been done in science to confirm, in the minds of men, that disposition to experimental verification which had scarcely yet taken full and secure root.' Discourse, &c., § 246.

Dr. Hippus draws a very useful distinction between tests or experimenta crucis which are decisive both ways and those which are what he calls *unilateral:*

'Thus, if a flame burns in any gas submitted to experiment, we may roughly (though only roughly) conclude that such gas contains oxygen; but, if the flame is extinguished, we cannot, therefore, conclude that the gas contains no oxygen, for the oxygen present may be in too close combination with some other substance, to enable it to support combustion. But a perfect test would be weighing any gas; for if it be heavier than common air, in the ratio of 1.435 to 1.2, it is oxygen; if lighter or heavier it is not. Thus, too, in discussing whether a given writing be innocent or libellous, that is, maliciously composed, or composed with any improper motive of any kind, the truth is a unilateral test; for if the allegations be false, there must be malice; but there may be malice also, though the matter stated be true. There would arise very great distinctness in argumentation, were we to adopt this convenient phrase of a complete and an incomplete or unilateral test—many of the errors in reasoning, especially upon moral subjects, arising from mistaking incomplete for complete tests.' Account, &c., pt. ii. p. 20. I have been compelled, for the sake of clearness, to alter the phraseology of the first sentence.

[70] In other words, an account of the difficulty of disentangling from the mass of antecedents the one which stands in the relation of cause to the given effect.

et per illas perficiatur. Interdum autem Instantiae Crucis illae occurrunt et inveniuntur inter jampridem notatas[71]; at ut plurimum novae sunt, et de industria atque ex composito quaesitae et applicatae, et diligentia sedula et acri tandem erutae.

(1) Exempli gratia; sit natura inquisita Fluxus et Refluxus Maris, ille bis repetitus in die atque sexhorarius in accessibus et recessibus singulis, cum differentia nonnulla quae coincidit in motum lunae[72]. Bivium circa hanc naturam tale est.

Necesse prorsus est ut iste motus efficiatur, vel ab aquarum progressu et regressu, in modum aquae in pelvi agitatae[73], quae

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[71] As, for instance, among the 'instantiae solitariae,' 'instantiae ostensivae,' &c. In fact, as already noticed, Bacon's 'instances' are, by no means, mutually exclusive, and a 'crucial instance' always falls under the head of 'solitary instances,' and generally under some other head as well. Most crucial instances, however, are specially invented for the purpose of enabling us to decide between rival hypotheses, and hence, under whatever other head they may fall, they are primarily crucial instances. They are made, not found. This is what Bacon appears to mean by the next clause.

[72] For Bacon's views as to the influence of the moon on the spring and neap tides, see my note on the following passage in Aph. 45: 'Rursus, si sit aliqua vis magnetica, quae operetur per consensum * * * inter globum lunae et aquas maris (quae maxime credibilis videtur in fluxibus et refluxibus semi-menstruis).' The semi-menstrual and semi-diurnal phenomena of the tides were at this time frequently explained on distinct principles.

[73] This view was maintained by Galileo. See Dialogi dei Massimi Sistemi, Giornata iv. He refers the alternate ebb and flow of the waters to the composition of the annual and diurnal motions of the earth. 'It being therefore presupposed, that there are such contrarieties of motions in the parts of the terrestrial surface, whilst it turneth round upon its own centre, it is necessary, that in conjoyning this diurnal motion, with the other annual, there do result an absolute motion for the parts of the said terrestrial superficies, one while very accelerate, and another while as slow again. * * * * * * * We will conclude therefore, that like as it is true the motion of the whole globe, and of each of its parts, would be equal and uniforme, in case they did move with one single motion, whether it were the meer annual, or the single diurnal revolution, so it is requisite, that mixing those two motions together, there do result thence for the parts of the said globe irregular motions, one while accelerated, and another while retarded, by means of the additions or subtractions of the diurnal conversion from the annual circulation. So that, if it be true (and most true it is, as experience proves) that the acceleration and retardation of the motion of the vessel, makes water contained therein

quando latus unum pelvis alluit, deserit alterum; vel a sublatione et subsidentia aquarum e profundo, in modum aquae ebullientis et rursus subsidentis[74]. Utri vero causae fluxus et refluxus ille assignari debeat, oritur dubitatio. Quod si recipiatur prior assertio, necesse est ut cum sit fluxus in mari ex una parte, fiat sub idem tempus alicubi in mari refluxus ex alia. Itaque ad hoc reducitur inquisitio. Atqui observavit Acosta, cum aliis nonnullis (diligenti facta inquisitione), quod ad litora Floridae et ad litora adversa Hispaniae et Africae, fiant fluxus maris ad eadem tempora, et refluxus itidem ad

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to run to and again the long wayes of it, and to rise and fall in its extreames, who will make scruple of granting, that the said effect may, nay ought to succeed in the sea-waters, contained within their vessels, subject to such like alterations, and especially in those that distend themselves long-wayes from West to East, which is the course that the motion of those same vessels steereth? Now this is the most potent and primary cause of the ebbing and flowing, without the which no such effect would ensue.' Sir Thomas Salusbury's Translation, pp. 389-390. See Florence Ed. of 1842, vol. i. pp. 462-4. The idea that the tides are due to the influence of the moon is alluded to and ridiculed by Galileo a few pages above. See p. 455 (Sir Thomas Salusbury's Translation, p. 383). It is noticed by Mr. Ellis (E. and S., vol. iii. p. 44) that Galileo's theory was first propounded in a letter to Cardinal Orsino, dated 1616. This is to be found in the Florence Edition of Galileo's Works, vol. ii. pp. 387-406.

[74] From what follows, it is plain that Bacon, had he adopted this alternative, would have explained it by a magnetic force, attracting the waters. But, as Mr. Ellis says (E. and S., vol. iii. p. 41), 'One theory, that of Telesius and Patricius, compares the sea to the water in a caldron; that is to say, it rises and tends to boil over when its natural heat is called forth under the influence of the sun, moon, and stars, and then after a while subsides.' On this, and the other curious theories by which the action of the tides was explained by Bacon's predecessors and contemporaries, see the very interesting preface, prefixed by Mr. Ellis to the Tract De Fluxu et Refluxu Maris, Bacon's Works, vol. iii. pp. 39-46.

To this Preface and to some good account of the theory and phenomena of the tides, such as may be found in the Encyclopaedia Britannica or Encyclopaedia Metropolitana, the student must be, once for all, referred for further information on this subject. It would be a waste of labour to attempt here to criticise or correct Bacon's remarks in detail. It may be sufficient to state generally that he confounds throughout currents and derivative tides with tides proper.

With what Bacon says on the tides in this Aphorism, we should compare the passage in Aph. 35, and also that on the phenomena of spring and neap tides in Aph. 45, referred to in note 72 above. See also my notes on both these passages.

eadem tempora; non contra, quod cum fluxus fit ad littora Floridae, fiat refluxus ad littora Hispaniae et Africae[75]. Attamen adhuc diligentius attendenti, non per hoc evincitur motus attollens, et abnegatur motus in progressu. Fieri enim potest, quod sit motus aquarum in progressu, et nihilominus inundet adversa littora ejusdem alvei simul; si aquae scilicet illae contrudantur et compellantur aliunde, quemadmodum fit in fluviis, qui fluunt et refluunt ad utrumque littus horis iisdem, cum tamen iste motus liquido sit motus in progressu, nempe aquarum ingredientium ostia fluminum ex mari. Itaque simili modo fieri potest, ut aquae venientes magna mole ab Oceano Orientali Indico compellantur et trudantur in alveum Maris Atlantici, et propterea inundent utrumque latus simul. Quaerendum itaque est, an sit alius alveus per quem aquae possint iisdem temporibus minui et refluere. Atque praesto est Mare Australe[76], Mari Atlantico neutiquam minus, sed potius magis latum et extensum, quod ad hoc sufficere possit.

Itaque jam tandem perventum est ad *instantiam crucis* circa hoc subjectum. Ea talis est: si pro certo inveniatur, quod cum fit fluxus ad littora adversa tam Floridae quam Hispaniae in Mari Atlantico, fiat simul fluxus ad littora Peruviae et juxta dorsum Chinae in Mari Australi; tum certe per hanc *instantiam decisoriam* abjudicanda est assertio quod fluxus et refluxus maris, de quo inquiritur, fiat per motum progressivum[77]: neque enim relinquitur aliud mare aut locus, ubi possit ad eadem tempora fieri regressus aut refluxus. Commodissime autem hoc sciri possit, si inquiratur ab incolis Panamae et Limae (ubi uterque Oceanus, Atlanticus et Australis, per parvum Isthmum separantur), utrum ad contrarias Isthmi partes fiat simul fluxus et refluxus maris, an

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[75] Mr. Ellis says: 'I have not been able to find this statement in Acosta, who speaks of the synchronism of the tides on the opposite sides of South America, as shewn by the meeting of the tidal waves in the Straits of Magellan (iii. 14).' For further information on the observations and theories of Acosta, see Mr. Ellis' Preface to the De Fluxu et Refluxu Maris, vol. iii. pp. 45–6.

[76] Including what we now call the Southern and Pacific Oceans.

[77] These facts, if established, would certainly have disproved the theory in question.

e contra. Verum haec decisio sive abjudicatio certa videtur, posito quod terra stet immobilis. Quod si terra rotet, fieri fortasse potest ut ex inaequali rotatione (quatenus ad celeritatem sive incitationem) terrae et aquarum maris, sequatur compulsio violenta aquarum in cumulum sursum, quae sit fluxus: et relaxatio earundem (postquam amplius cumulari non sustinuerint) in deorsum, quae sit refluxus[78]. Verum de hoc facienda est inquisitio separatim. Attamen etiam hoc supposito, illud aeque manet fixum, quod necesse sit fieri alicubi refluxum maris ad eadem tempora quibus fiunt fluxus in aliis partibus.

Similiter, sit natura inquisita posterior ille motus ex duobus quos supposuimus, videlicet motus maris se attollens et rursus subsidens; si forte ita acciderit ut (diligenti facto examine) rejiciatur motus alter, de quo diximus, progressivus. Tum vero erit trivium circa hanc naturam tale. Necesse est ut motus iste, per quem aquae in fluxibus et refluxibus se attollunt et rursus relabuntur, absque aliqua accessione aquarum aliarum quae advolvuntur, fiat per unum ex his tribus modis; vel quod ista aquarum copia emanet ex interioribus terrae et rursus in illa se recipiat[79]; vel quod non sit aliqua amplior moles aquarum, sed quod eaedem aquae (non aucto quanto

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[78] Compare the theory of Galileo, noticed above, connecting the phenomenon of the tides with the rotation of the earth.

[79] 'Dubitatur etiamnum quibus ex causis intumescat Oceanus, vel quatenus, cum superfluus sibi fuerit, rursus in se residat. Nec in obscuro est, plura pro ingeniis differentium, potius quam pro veritatis fide expressa. Sed omisso ancipiti concurrentium quaestionum has opiniones probatissimas invenimus. Physici aiunt, mundum animal esse, eumque ex variis elementorum corporibus conglobatum, moveri spiritu, regi mente: quae utraque diffusa per membra omnia, aeternae molis vigorem exerceant. Sicut ergo in corporibus nostris commercia sunt spiritalia, ita in profundis Oceani nares quasdam mundi constitutas, per quas emissi anhelitus, vel reducti, modo inflent maria, modo revocent. At hi, qui siderum sequuntur disciplinam, contendunt meatus istos commoveri lunae cursibus: adeo ut vicissitudines inter maciem aquarum et plenitudinem, respiciant adauctus ejus, vel eliquia: neque eodem semper tempore, sed prout illa aut minuatur, aut crescat, variari alternantes recursus.' Solini Polyhistor. cap. xxiii. ad fin. Cp. with the latter opinion (which is to be found in the Pseudo-Aristotelian treatise, Περὶ Κόσμου, ch. 4. p. 396 a. 25–7), Pliny, Nat. Hist. ii. 97 (99), sect. 212, &c., who refers the tides to the joint action of the Sun and Moon.

suo) extendantur sive rarefiant, ita ut majorem locum et dimensionem occupent, et rursus se contrahant[80]; vel quod nec copia accedat major nec extensio amplior, sed eaedem aquae (prout sunt tam copia quam densitate aut raritate) per vim aliquam magneticam[81] desuper eas attrahentem et evocantem, et per consensum, se attollant et deinde se remittant. Itaque reducatur (si placet) jam inquisitio (missis duobus illis motibus prioribus) ad hunc ultimum; et inquiratur si fiat aliqua talis sublatio per consensum sive vim magneticam. Atqui primo manifestum est universas aquas, prout ponuntur in fossa sive cavo maris, non posse simul attolli, quia defuerit quod succedat in fundo; adeo ut si foret in aquis aliquis hujusmodi appetitus se attollendi, ille ipse tamen a nexu rerum, sive (ut vulgo loquuntur) ne detur vacuum[82], fractus foret et cohibitus. Relinquitur, ut attollantur aquae ex aliqua parte, et per hoc minuantur et cedant ex alia. Enimvero

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[80] This would be the opinion of Telesius and Patricius, referred to above in note 74. The same theory is maintained by Campanella.

[81] See Gilbert, De Magnete, lib. ii. cap. 16 ad fin. From him Bacon may have taken the idea, which, if we compare the remarkable passage on attraction in Aph. 45, he evidently seems inclined to adopt in reference to the phenomena of spring and neap tides.

In Kepler's Epitome Astronomiae Copernicanae, published in 1618, we find the following passage: 'Quemadmodum igitur, ut Magnes Magnetem aut ferrum trahat, cognatio corporum efficit: sic etiam de Luna non est incredibile, ut illa moveatur a Terrae cognato corpore: licet nec hic nec illic intercedat aliquis contactus corporum. Adeoque quid mirum, Lunam a terra moveri, cum videamus vicissim et Lunam transitu suo super vertices locorum causare fluxum Oceani reciprocum in Tellure? Nonne satis evidens hoc est documentum communicationis motuum inter haec duo corpora?'

Gassendi, in his account of the various opinions on the causes of the tides (Physicae, Sectio iii. Membrum Prius, lib. i. cap. 4), says: 'Plurimi recurrunt ad Magneticam, seu tractoriam vim, qua nimirum Luna supra mare transiens, ipsius aquas ad se alliciat, post transitum retro relaxet; sicque mare cogens intumescere detumescereque, Affluxum et Refluxum creet.'

[82] We have seen already (ii. 8 ad init.) that Bacon denies the possibility of a vacuum. See also Aph. 48, Motus Secundus. As remarked by Mr. Ellis in his Preface to the Historia Densi et Rari (E. and S., vol. ii. p. 238), Bacon's opinions on this subject must have undergone a decided change after the time of his writing the Cogitationes de Rerum Natura and the Fable of Cupid.

rursus necessario sequetur ut vis illa magnetica, cum super totum operari non possit, circa medium operetur intensissime; ita ut aquas in medio attollat, illae vero sublatae latera per successionem deserant et destituant.

Itaque jam tandem perventum est ad *instantiam crucis* circa hoc subjectum. Ea talis est: si inveniatur quod in refluxibus maris aquarum superficies in mari sit arcuata magis et rotunda, attollentibus se scilicet aquis in medio maris et deficientibus circa latera, quae sunt litora; et in fluxibus eadem superficies sit magis plana et aequa, redeuntibus scilicet aquis ad priorem suam positionem [83]; tum certe per hanc *instantiam decisoriam* potest recipi sublatio per vim magneticam, aliter prorsus abjudicanda est. Hoc vero in fretis per lineas nauticas non difficile est experiri [84]; videlicet utrum in refluxibus versus medium maris, mare non sit magis altum sive profundum quam in fluxibus. Notandum autem est, si hoc ita sit, fieri (contra ac creditur) ut attollant se aquae in refluxibus, demittant se tantum in fluxibus, ita ut littora vestiant et inundent.

(2) Similiter, sit natura inquisita Motus Rotationis spontaneus [85]; et speciatim, utrum Motus Diurnus, per quem sol et stellae ad conspectum nostrum oriuntur et occidunt, sit motus rotationis verus in coelestibus, aut motus apparens in coelestibus, verus in terra. Poterit esse *instantia crucis* super hoc subjectum talis. Si inveniatur motus aliquis in oceano ab oriente in occidentem, licet admodum languidus et enervatus; si idem motus reperiatur paulo incitatior in aëre, praesertim intra tropicos, ubi propter majores circulos est magis perceptibilis; si idem motus reperiatur in humilioribus cometis, jam factus vivus et validus; si idem motus reperiatur in planetis, ita tamen dispensatus et graduatus ut quo propius absit a terra sit tardior, quo longius celerior, atque in coelo

[83] This is the case, though we know it to be so rather as a deduction from the theory of the tides than from the observation of facts. The curvature is greatest when the tide is high, and least when it is low.

[84] 'In fretis' the tides are derivative, and, consequently, the experiment would not be conclusive.

[85] Of this 'motus rotationis spontaneus' we shall hear more in Aph. 48, Motus xvii. See also Aph. 5, ad fin. These passages shew how far Bacon was from having formed any true conception of the nature of Motion.

demum stellato sit velocissimus: tum certe recipi debet motus diurnus pro vero in coelis, et abnegandus est motus terrae; quia manifestum erit, motum ab oriente in occidentem esse plane cosmicum et ex consensu universi, qui in summitatibus coeli maxime rapidus gradatim labascat, et tandem desinat et extinguatur in immobili, videlicet terra [86].

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[86] If the heavens revolved with an uniform motion round the earth, it is plain that the more remote a point is from the earth, the more rapid would be its motion. But, suppose the earth to revolve on its axis, we should have exactly the same set of appearances as on the former supposition, and, if we were ignorant of the fact of the earth's rotation, we should imagine a distant point to move with much greater rapidity than a point which is near. Hence the conditions of this so-called Crucial Instance, even if satisfied, would equally well suit either hypothesis. But they are evidently complicated by the consideration of the proper motions of the planets and comets.

Dr. Whewell, who comments at some length on this example (History of the Inductive Sciences, 3rd Ed., Additions, vol. i. pp. 388–390), adduces it as shewing that Bacon, at least in his later years, was not so much opposed, as is commonly thought, to the Copernican theory. 'With regard to the diurnal motion of the earth,' he says, 'it would seem as if Bacon himself had a leaning to believe it when he wrote this passage; for neither is he himself, nor are any of the Anti-Copernicans, accustomed to assert that the immensely rapid motion of the sphere of the Fixed Stars graduates by a slower and slower motion of Planets, Comets, Air and Ocean, into the immobility of the Earth. So that the conditions are not satisfied on which he hypothetically says, "tum abnegandus est motus terrae."' I must confess, however, that I cannot take so favourable a view. See Aph. 46, where, speaking of the enormous velocity implied by the diurnal motion of the heavens, he says, 'quae etiam viros graves ita obstupefecit, ut mallent credere motum terrae,' evidently regarded as an extreme supposition. Cp. also the end of the next paragraph of that Aphorism, and Aph. 35, where, in discussing rest and motion, he says, 'statio, sive quies, videtur competere globo ipsi terrae.'

In the Introduction, Section 6, Bacon's attitude to the Copernican theory is discussed at some length. We must, of course, distinguish the passages in which he speaks of the diurnal from those in which he speaks of the annual motion of the earth. But that Whewell's argument, as derived from the passage in the text, is delusive, is plain from comparing a corresponding passage in the De Fluxu et Refluxu Maris (E. and S., vol. iii. p. 53), where Bacon states dogmatically that it is an invariable rule that, the nearer a body approaches the earth, the slower is its motion of rotation.

It may be worth noticing that Telesius (De Rerum Natura, i. 3) insists on the motion of the air, resting the position partly on authority and

Similiter, sit natura inquisita Motus Rotationis ille alter apud astronomos decantatus, renitens et contrarius Motui Diurno, videlicet ab occidente in orientem[87]; quem veteres astronomi attribuunt planetis, etiam coelo stellato[88], at Copernicus et ejus sectatores terrae quoque[89]; et quaeratur utrum inveniatur in rerum natura aliquis talis motus, an potius res conficta sit et supposita, ad compendia et commoditates calculationum, et ad pulchrum illud, scilicet de expediendis motibus coelestibus per circulos perfectos. Neutiquam enim evincitur iste motus esse in supernis verus et realis, nec per defectum restitutionis planetae in motu diurno ad idem punctum coeli stellati, nec per diversam politatem zodiaci, habito respectu ad polos mundi; quae duo nobis hunc motum pepererunt. Primum enim phaenomenon per anteversionem et derelictionem optime salvatur; secundum

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partly on the sound produced by putting the hand or a horn to the ear. Bacon recurs to the motion of the air and water in ii. 48 (17), where he seems to entertain no doubt on the subject.

[87] 'The astronomers,' Bacon often says, 'insist on explaining the retardation of the inferior orbs by giving them a proper motion of their own, opposite to that which they derive from the starry heaven: surely it would be simpler to say that all the orbs move in the same direction with unequal velocities; the inequality depending on their remoteness from the prime mover.' Mr. Ellis' Preface to the Descriptio Globi Intellectualis, E. and S., vol. iii. p. 720. To this Preface, to the Descriptio Globi Intellectualis and Thema Coeli themselves, to the De Augmentis, iii. 4, to the De Fluxu et Refluxu Maris, and to the De Principiis atque Originibus, I must, once for all, refer the reader who is interested in ascertaining the peculiar astronomical theories to which Bacon inclined. Any elaborate examination of his views, or even of the present passage, would carry me far beyond the objects of this edition. Towards the end of the Thema Coeli (E. and S., vol. iii. p. 779) he distinctly denies the reality of the motion from W. to E., and refers the phenomena of planetary motion to differences of speed.

[88] He is referring to those systems which made the coelum stellatum distinct from the primum mobile. See Gassendi, Physicae Sectio II. lib. iii. cap. 2 ad fin. Speaking of Fracastorius, who proposed the most complicated of all the systems of Concentrics, Gassendi says: 'At sphaerae Aplane, Stellarum Inerrantium istis omnibus' (i. e. the planetary spheres) 'superiori super extruxisse motibus ipsius variandis quinque alias, quibus adhuc fuerit Mobile Primum superponendum, adeo proinde, ut sphaeras statuerit septuaginta duas, aut saltem septuaginta.'

[89] For the old notion that the heavens revolve from E. to W., Copernicus substituted the hypothesis that the earth itself revolves from W. to E.

per lineas spirales; adeo ut inaequalitas restitutionis et declinatio ad tropicos possint esse potius modificationes motus unici illius diurni, quam motus renitentes aut circa diversos polos. Et certissimum est, si paulisper pro plebeiis nos geramus (missis astronomorum et scholae commentis, quibus illud in more est ut sensui in multis immerito vim faciant, et obscuriora malint), talem esse motum istum ad sensum [90], qualem diximus; cujus imaginem per fila ferrea (veluti in machina) aliquando repraesentari fecimus.

Verum *instantia crucis* super hoc subjectum poterit esse talis. Si inveniatur in aliqua historia fide digna, fuisse cometam aliquem vel sublimiorem vel humiliorem [91] qui non

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[90] 'On his assertion,' says Dr. Whewell (in the passage referred to above), 'that the motion of each separate planet is, to sense, a spiral, we may remark that it is certainly true; but that the business of science, here, as elsewhere, consists in *resolving* the complex phenomenon into simple phenomena; the complex spiral motion into simple circular motions.' Bacon, both here and elsewhere, when he has occasion to treat of astronomical questions (see, for instance, De Augmentis, iii. 4), depreciates the importance of mathematical calculations as applied to the motions of the heavenly bodies. And yet, without the aid of mathematics, where would have been the modern science of Astronomy? The simultaneous discovery of the planet Neptune by Adams and Le Verrier, as a result of the most elaborate mathematical investigations, is alone a sufficient refutation of Bacon's view. Formal Astronomy, or the consideration of the apparent motions of the heavenly bodies in Space and Time, was an essential prelude to Physical Astronomy, or the reference of these motions to their causes in Force and Matter. But, though Bacon went too far in depreciating Formal Astronomy, we must not forget that he was one of the first to point out the importance of Physical Astronomy, as well as of establishing a closer union between both branches of the science: 'Quamobrem hanc partem Astronomiae, quae Physica est, desiderari statuimus. Eam Astronomiam Vivam nominabimus, ad differentiam bovis illius Promethei suffarcinati, et solummodo figura tenus bovis.' De Augm. iii. 4. Cp. Descriptio Globi Intellectualis, cap. 5. See also Introduction, pp. 37, 38.

[91] The distinction of higher and lower comets may be found in Seneca, Nat. Quaest. vii. 6, 7, and is there referred to Epigenes. Bacon, in the De Fluxu et Refluxu Maris (E. and S., vol. iii. p. 53), speaks of the 'lower comets' as being lower than the orb of the moon. By many ancient philosophers, all comets were regarded as sublunar. It is needless to remark that, on the other hand, all true comets belong to the solar, and not to the terrestrial system. In reading ancient authors, however, it must always be borne in mind that they often designated mere atmospheric meteors by the name of comets.

rotaverit cum consensu manifesto (licet admodum irregulariter) motus diurni, sed potius rotaverit in contrarium coeli [92]; tum certe hucusque judicandum est posse esse in natura aliquem talem motum. Sin nihil hujusmodi inveniatur, habendus est pro suspecto, et ad alias *instantias crucis* circa hoc confugiendum.

(3) Similiter, sit natura inquisita Pondus sive Grave [93]. Bivium circa hanc naturam tale est. Necesse est ut gravia et ponderosa vel tendant ex natura sua ad centrum terrae, per proprium schematismum; vel ut a massa corporea ipsius terrae, tanquam a congregatione corporum connaturalium, attrahantur et rapiantur, et ad eam per consensum ferantur. At posterius hoc si in causa sit, sequitur ut quo propius gravia appropinquant ad terram, eo fortius et majore cum impetu ferantur ad eam; quo longius ab ea absint, debilius et tardius (ut fit in attractionibus magneticis); idque fieri intra spatium

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[92] Whereas the planets and their satellites, with the sole known exception of the satellites of Uranus, revolve with what is called a *direct* motion, that is, from W. to E., the comets seem to be almost equally divided between those which have a *direct* motion, from W. to E., and those which have a *retrograde* motion, from E. to W. But what Bacon desiderated was a comet whose proper motion from W. to E. more than compensated for the apparent diurnal motion of the heavens from E. to W., so that it might visibly move in the opposite direction to the heavens. This, it appears, would have convinced him that there is a motion of rotation from W. to E., and that this motion, which he regarded as feigned simply for the purpose of facilitating the calculations of astronomers ('res conficta et supposita,' &c.), is not merely a modification of the diurnal motion. If no such instance can be found, then, he says, we must continue to suspect the theory, till we can find some other crucial instance to settle the question.

[93] This paragraph does great credit to Bacon's sagacity, and is one of those which give him a claim to be regarded as a pioneer of science as well as a reformer of method. 'Voltaire,' says Mr. Ellis, 'cites the passage in the text in support of his remark that "le plus grand service, peut-être, que F. Bacon ait rendu à la philosophie a été de deviner l'attraction." But in reality the notion of attraction in one form or other (e. g. the attraction of the sea by the moon) sprang up in the infancy of physical speculation; and it cannot be affirmed that Bacon's ideas on the subject were as clear as those of his predecessor William Gilbert.' This criticism, I think, does Bacon scant justice. Even if the idea was suggested to him by the work of Gilbert, he ought, at least, to have the credit of having detached the conception of attraction from that of magnetism. Cp., however, p. 479, n. 25.

certum; adeo ut si elongata fuerint a terra tali distantia ut virtus terrae in ea agere non possit, pensilia mansura sint, ut et ipsa terra, nec omnino decasura.

Itaque talis circa hanc rem poterit esse *instantia crucis*. Sumatur horologium[94] ex iis quae moventur per pondera plumbea, et aliud ex iis quae moventur per compressionem laminae ferreae; atque vere probentur, ne alterum altero velocius sit aut tardius; deinde ponatur horologium illud movens per pondera super fastigium alicujus templi altissimi, altero illo infra detento; et notetur diligenter si horologium in alto situm tardius moveatur quam solebat, propter diminutam virtutem ponderum. Idem fiat experimentum in profundis minerarum alte sub terra depressarum, utrum horologium hujusmodi non moveatur velocius quam solebat, propter auctam virtutem ponderum. Quod si inveniatur virtus ponderum minui in sublimi, aggravari in subterraneis[95], recipiatur pro causa ponderis attractio a massa corporea terrae.

(4) Similiter, sit natura inquisita Verticitas Acus Ferreae, tactae magnete. Circa hanc naturam tale erit bivium. Necesse est ut tactus magnetis vel ex se indat ferro verticitatem ad septentriones et austrum; vel ut excitet ferrum tantummodo et habilitet, motus autem ipse indatur ex praesentia terrae; ut Gilbertus opinatur, et tanto conatu probare nititur[96]. Itaque

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[94] By this he must have meant a fly-clock, pendulum clocks not being yet known.

[95] Ingenious as the proposed experiment is, it shews an ignorance of—what, indeed, Bacon could not be expected to know—the difference in the law of attraction above, on, and below the earth's surface. For, while the attraction of a homogeneous sphere on a particle external to it varies inversely as the square of the distance from the centre, the attraction of the same sphere on a particle upon or below its surface varies directly as the distance from the centre. Hence, the force of attraction reaches a maximum on the surface, and diminishes as we descend a mine, or as we ascend upwards from the surface of the earth. In other words, a clock moved by weights ought to go slower and slower, both the higher we ascend a mountain and the lower we descend a mine. In the former part of his supposition, therefore (which, taken by itself, furnishes a sufficient Crucial Instance), Bacon is right, in the latter wrong.

On the whole of this passage, the student should refer to Herschel's Discourse on the Study of Natural Philosophy, § 196. I have also noticed it in my Introduction, p. 39.

[96] See Gilbert, De Magnete, throughout, and especially lib. vi. cap. 1.

huc spectant ea, quae ille perspicaci industria conquisivit. Nimirum quod clavus ferreus, qui diu duravit in situ versus septentriones et austrum, colligat mora diutina verticitatem, absque tactu magnetis[97]: ac si terra ipsa, quae ob distantiam debiliter operatur (namque superficies aut extima incrustatio terrae virtutis magneticae, ut ille vult, expers est), per moram tamen longam magnetis tactum suppleret, et ferrum exciret, deinde excitum conformaret et verteret. Rursus, quod ferrum ignitum et cadens, si in extinctione sua exporrigatur inter septentriones et austrum, colligat quoque verticitatem absque tactu magnetis: ac si partes ferri in motu positae per ignitionem, et postea se recipientes, in ipso articulo extinctionis suae magis essent susceptivae et quasi sensitivae virtutis manantis a terra quam alias, et inde fierent tanquam excitae. Verum haec, licet bene observata, tamen non evincunt prorsus quod ille asserit.

Instantia crucis autem circa hoc subjectum poterit esse talis. Capiatur terrella ex magnete, et notentur poli ejus; et ponantur poli terrellae versus orientem et occasum, non versus septentriones et austrum, atque ita jaceant; deinde superponatur acus ferrea intacta, et permittatur ita manere ad dies sex aut septem. Acus vero (nam de hoc non dubitatur) dum manet super magnetem, relictis polis mundi, se vertet ad polos magnetis; itaque quamdiu ita manet, vertitur scilicet ad orientem et occidentem mundi. Quod si inveniatur acus illa, remota a magnete et posita super versorium, statim se applicare ad septentriones et austrum, vel etiam paulatim se eo recipere, tum recipienda est pro causa, praesentia terrae; sin aut vertatur (ut prius) in orientem et occidentem, aut perdat verticitatem, habenda est illa causa pro suspecta, et ulterius inquirendum est[98].

There can now be no doubt of the truth of the latter alternative. The earth may be regarded as a vast magnet, whose poles are at some distance from the terrestrial poles, the angle which the magnetic makes with the geographical meridian being known as the declination or variation of the magnetic needle.

[97] De Magnete, iii. 12. The same chapter also contains an account of the next observation.

[98] The former alternative, of course, represents the facts. A needle, however magnetised, will, when allowed to turn freely, and removed from the influence of any other magnet, direct itself north and south.

(5) Similiter, sit natura inquisita Corporea Substantia Lunae[99]: an sit tenuis, flammea, sive aërea, ut plurimi ex priscis philosophis opinati sunt; an solida et densa, ut Gilbertus[1] et multi moderni, cum nonnullis ex antiquis, tenent. Rationes posterioris istius opinionis fundantur in hoc maxime, quod luna radios solis reflectat; neque videtur fieri reflexio lucis nisi a solidis[2].

Itaque *instantiae crucis* circa hoc subjectum eae esse poterint (si modo aliquae sint) quae demonstrent reflexionem a corpore tenui, qualis est flamma, modo sit crassitiei sufficientis[3]. Certe

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[99] The nature of the substance of the heavenly bodies generally is considered in the Descriptio Globi Intellectualis, cap. 7, and in the Thema Coeli.

[1] This must be an allusion to Gilbert's known opinions, not to his writings. For the posthumous book De Mundo nostro Sublunari, which contains his speculations on this subject, was not published till 1651. It may, however, have been read by Bacon in manuscript (see note 82 on Aph. 48 (8)). In this work, lib. ii. capp. 13–16, Gilbert passes in review the various opinions of the ancients, and himself arrives at the following conclusion: 'Luna, diversa natura a Sole, est solida absque lumine substantia, diversa in eminentiis; non provenit unquam ab inspissatione imaginatae quintae essentiae, adeo ut densior pars sit sphaerae nugatoriae: sed astrum est, sicut tellus, suis spatiis motum habens. Tellus vero etiam sicut altera Luna est, quae etiam a Sole accepto lumine versus Lunam relucet, sicut Luna conceptum a Sole lumen in tellurem remittit; omne enim solidum lumen remittit.' For Aristotle's fifth element (quintessence), or aether, which he regarded as having a circular motion, and as extending *ἄνω καὶ μέχρι σελήνης*, see, amongst other places, Meteorologica, i. 3, De Coelo, i. 3, De Animalium Generatione, ii. 3, and the spurious treatise De Mundo, ch. 2. In the last passage, which represents the doctrines of the Peripatetic school, the writer says: *οὐρανοῦ δὲ καὶ ἄστρων οὐσίαν μὲν αἰθέρα καλοῦμεν, . . . στοιχεῖον οὖσαν ἕτερον τῶν τεττάρων, ἀκήρατόν τε καὶ θεῖον.* In the De Animalium Generatione, iii. 11 (p. 761 b. 21, 22), Aristotle speaks of the moon as composed of fire: *ἀλλὰ δεῖ τὸ τοιοῦτον γένος* (sc. *τὸ τοῦ πυρός*) *ζητεῖν ἐπὶ τῆς σελήνης· αὕτη γὰρ φαίνεται κοινωνοῦσα τῆς τετάρτης ἀποστάσεως.*

[2] This is certainly not Gilbert's argument, as it appears in his book. He argues quite rightly (lib. ii. cap. 13) to the opacity and solidity of the moon from the fact that, in a Solar Eclipse, it does not transmit any of the light of the Sun: 'Videmus enim in deliquiis solaribus, tanquam opacissima mole, Solis lumen sisti et averti.' So far from stating that light is reflected only from solid bodies, he refers, in the course of his discussion, to the very familiar fact of the reflection of light from water.

[3] All bodies, which are not absolutely black or absolutely transparent, reflect light, though, of course, in the most varying degrees. A flame is simply an ignited gas.

causa crepusculi, inter alias, est reflexio[4] radiorum solis a superiore parte aëris. Etiam quandoque reflecti videmus radios solis temporibus vespertinis serenis a fimbriis nubium roscidarum, non minori splendore, sed potius illustriori et magis glorioso, quam qui redditur a corpore lunae[5]; neque tamen constat eas nubes coaluisse in corpus densum aquae. Etiam videmus aërem tenebrosum pone fenestras noctu reflectere lucem candelae, non minus quam corpus densum[6]. Tentandum etiam foret experimentum immissionis radiorum solis per foramen super flammam aliquam subfuscam et caeruleam. Sane radii aperti solis, incidentes in flammas obscuriores, videntur eas quasi mortificare, ut conspiciantur magis instar fumi albi quam flammae. Atque haec impraesentiarum occurrunt, quae sint ex natura *instantiarum crucis* circa hanc rem[7]; et meliora fortasse reperiri possunt. Sed notandum semper est, reflexionem a flamma non esse expectandam, nisi a flamma alicujus profunditatis; nam aliter vergit ad diaphanum. Hoc autem pro certo ponendum, lucem semper in corpore aequali[8] aut excipi et transmitti, aut resilire.

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[4] Refraction, as well as Reflexion, enters into the explanation of this and similar phenomena.

[5] Mr. Ellis remarks that the comparison of the brightness of the moon in the daytime with that of a cloud was ingeniously applied by Bouguer to determine the ratio of the moon's light to the sun's.

[6] 'Bacon's reason for this phenomenon is wrong. It is really the polished surface of the glass which reflects the rays: and this is always the case, but is only visible to us when there is neither light nor object on the other side to destroy the image created.' Mr. Kitchin's note.

[7] All that these Instances prove is that other than solid bodies reflect light, and hence it follows that, *because* the moon reflects light, we cannot infer that it is a solid body. But, though they dispose of the argument, they do not dispose of the conclusion. How little Bacon anticipated that the time would come, when we should be able to weigh the moon, to know something of its chemical constituents, and to map out its surface with perfect accuracy!

The question whether other than solid bodies reflect light is a good example of an *unilateral* test (see the end of the first note on this Aphorism). If decided one way, it proves that the moon is a solid body; if decided the other way, it proves nothing.

[8] Cp. Aph. 23. There, he says, 'corpora omnino aequalia (secundum portiones opticas) dare diaphanum.' The optical generalisation that every ray of light incident on a surface is either reflected, or transmitted, or

(6) Similiter, sit natura inquisita Motus Missilium, veluti spiculorum, sagittarum, globulorum, per aërem. Hunc motum Schola (more suo) valde negligenter expedit; satis habens, si eum nomine motus violenti a naturali[9] (quem vocant) distinguat; et quod ad primam percussionem sive impulsionem attinet, per illud, (*quod duo corpora non possint esse in uno loco, ne fiat penetratio dimensionum*,) sibi satisfaciat; et de processu continuato istius motus nihil curet. At circa hanc naturam bivium est tale: aut iste motus fit ab aëre vehente et pone corpus emissum se colligente, instar fluvii erga scapham aut venti erga paleas; aut a partibus ipsius corporis non sustinentibus impressionem, sed ad eandem laxandam per successionem se promoventibus. Atque priorem illum recipit Fracastorius[10], et fere omnes qui de hoc motu paulo subtilius inquisiverunt:

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absorbed, or disposed of in all or some of these ways, was, of course, unknown to Bacon.

[9] See notes on i. 66, ii. 35.

[10] De Sympathia et Antipathia, cap. 4: 'Projecta quoque per eandem rarefactionem et condensationem portantur per aerem, partibus quidem, quae ante sunt, viam quodammodo aperientibus, et propellentibus undationem, iis vero, quae circa et a tergo, successive addensatis et rarefactis una post aliam, et projectum vehentibus non aliter ac per undam,' &c. He then attempts to account for the motion being slow at first, quicker afterwards, and ultimately ceasing altogether.

Mr. Ellis refers, for similar explanations, to Plato's Timaeus, p. 80 (Add. p. 79), and to Plutarch, Quaest. Platon. (Reiske's Plutarch, vol. x. p. 177, &c.). Of projectiles the latter, developing the Platonic doctrine, says: *τὰ δὲ ῥιπτούμενα βάρη τὸν ἀέρα σχίζει μετὰ πληγῆς ἐκπεσόντα, καὶ διΐστησιν. ὁ δὲ περιῤῥέων ὀπίσω, τῷ φύσιν ἔχειν ἀεὶ τὴν ἐρημουμένην χώραν διώκειν καὶ ἀναπληροῦν, συνέπεται τῷ ἀφιεμένῳ, τὴν κίνησιν συνεπιταχύνων.* He gives a similar account of lightning, cupping glasses, sounds, swallowing, and several other phenomena.

Aristotle also regards the motion of a projectile as maintained by the air. See Physics, iv. 8 (p. 215 a), viii. 10 (pp. 266 b, 267 a). In the former passage, he says: *ἔτι νῦν μὲν κινεῖται τὰ ῥιπτούμενα τοῦ ὤσαντος οὐχ ἁπτομένου, ἢ δι' ἀντιπερίστασιν, ὥσπερ ἔνιοί φασιν, ἢ διὰ τὸ ὠθεῖν τὸν ὠσθέντα ἀέρα θάττω κίνησιν τῆς τοῦ ὠσθέντος φορᾶς, ἣν φέρεται εἰς τὸν οἰκεῖον τόπον.* The latter passage, which is far the more elaborate, is too long to quote. On the former, Mr. Lewes comments in his work on Aristotle, pp. 132, 133.

To criticise this and similar theories of motion would be unduly to tax the patience of the reader. These very dark places of the ancient and mediaeval physics are at once illuminated by the simplicity of the First Law of Motion.

neque dubium est, quin sint aëris partes in hac re nonnullae; sed alter motus proculdubio verus est, ut ex infinitis constat experimentis[11]. Sed inter caeteras, poterit esse circa hoc subjectum *instantia crucis* talis; quod lamina, aut filum ferri paulo contumacius, vel etiam calamus sive penna in medio divisa, adducta et curvata inter pollicem et digitum, exiliant. Manifestum enim est, hoc non posse imputari aëri se pone corpus colligenti, quia fons motus est in medio laminae vel calami, non in extremis[12].

(7) Similiter sit natura inquisita motus ille rapidus et potens Expansionis Pulveris Pyrii in flammam[13]; unde tantae moles subvertuntur, tanta pondera emittuntur, quanta in cuniculis majoribus et bombardis videmus. Bivium circa hanc naturam tale est. Aut excitatur iste motus a mero corporis

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[11] Bacon did not see that the two cases which he had put were by no means exhaustive. Nor had he stated the problem rightly. The difficulty, as we now know, is not to account for the continued motion of a projectile, but for the cessation of its motion.

[12] He seems here, notwithstanding having drawn the distinction above, to mistake the question at issue, which was not as to the origin of the motion of a projectile, but as to its continuance. And even if his instance were to the point, it would only be decisive against the one theory, not in favour of the other.

In the Cogitationes De Natura Rerum, cap. 8 (E. and S., vol. iii. pp. 28–31), he treats this subject at greater length and adds other experiments, which are, however, no more decisive than the one given here.

[13] This question is also treated in the Cogitationes De Natura Rerum. See cap. 9. Bacon's solution of the difficulty by referring the explosion to the 'conflict of two bodies,' and his language about the 'crude spirit which is in nitre,' are thoroughly characteristic both of his own chemical views and, generally, of those of his time. Chemistry, we must recollect, had hardly as yet put on a scientific form, and, moreover, it was peculiarly encumbered by the use of a fanciful and metaphorical language.

As to the true explanation of the great explosive power of gunpowder, it 'is due to the sudden development of a large volume of gaseous bodies, chiefly consisting of nitrogen and carbonic anhydride, which, at the ordinary temperature of the air, would occupy a space equal to about 300 times the bulk of the powder used; but from the intense heat developed at the moment of the explosion, the dilation amounts to at least 1500 times the volume of the gunpowder employed.' Miller's Elements of Chemistry, Part ii. pp. 399–400. The principle of this explanation was first demonstrated by Jean Bernoulli. See Hoefer, Histoire de la Chimie, tome ii. pp. 264–265.

appetitu se dilatandi, postquam fuerit inflammatum; aut ab appetitu mixto spiritus crudi, qui rapide fugit ignem, et ex eo circumfuso, tanquam ex carcere, violenter erumpit. Schola autem et vulgaris opinio tantum versatur circa priorem illum appetitum. Putant enim homines se pulchre philosophari, si asserant flammam ex forma elementi necessitate quadam donari locum ampliorem occupandi quam idem corpus expleverat cum subiret formam pulveris, atque inde sequi motum istum. Interim minime advertunt, licet hoc verum sit, posito quod flamma generetur, tamen posse impediri flammae generationem a tanta mole, quae illam comprimere et suffocare queat; ut non deducatur res ad istam necessitatem de qua loquuntur. Nam quod necesse sit fieri expansionem, atque inde sequi emissionem aut remotionem corporis quod obstat, si generetur flamma, recte putant. Sed ista necessitas plane evitatur, si moles illa solida flammam supprimat antequam generetur. Atque videmus flammam, praesertim in prima generatione, mollem esse et lenem, et requirere cavum in quo experiri et ludere possit. Itaque tanta violentia huic rei per se assignari non potest. Sed illud verum; generationem hujusmodi flammarum flatulentarum, et veluti ventorum igneorum, fieri ex conflictu duorum corporum, eorumque naturae inter se plane contrariae; alterius admodum inflammabilis, quae natura viget in sulphure; alterius flammam exhorrentis, qualis est spiritus crudus qui est in nitro; adeo ut fiat conflictus mirabilis, inflammante se sulphure quantum potest (nam tertium corpus, nimirum carbo salicis, nil aliud fere praestat, quam ut illa duo corpora incorporet et commode uniat), et erumpente spiritu nitri quantum potest, et una se dilatante (nam hoc faciunt et aër, et omnia cruda, et aqua, ut a calore dilatentur), et per istam fugam et eruptionem interim flammam sulphuris, tanquam follibus occultis, undequaque exufflante.

Poterant autem esse *instantiae crucis* [14] circa hoc subjectum duorum generum. Alterum eorum corporum quae maxime

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[14] These 'crucial instances' dispose of the rival hypothesis, but they do not establish Bacon's own. To state exhaustively the various possible explanations in an example of this kind implies a far more scientific conception of the subject, than either Bacon or his contemporaries had yet attained.

sunt inflammabilia, qualia sunt sulphur, caphura, naphtha, et hujusmodi, cum eorum misturis; quae citius et facilius concipiunt flammam quam pulvis pyrius, si non impediantur: ex quo liquet appetitum inflammandi per se effectum illum stupendum non operari. Alterum eorum quae flammam fugiunt et exhorrent, qualia sunt sales omnes. Videmus enim, si jaciantur in ignem, spiritum aqueum erumpere cum fragore antequam flamma concipiatur; quod etiam leniter fit in foliis paulo contumacioribus, parte aquea erumpente antequam oleosa concipiat flammam. Sed maxime cernitur hoc in argento vivo, quod non male dicitur aqua mineralis. Hoc enim, absque inflammatione, per eruptionem et expansionem simplicem vires pulveris pyrii fere adaequat; quod etiam admixtum pulveri pyrio ejus vires multiplicare dicitur.

(8) Similiter sit natura inquisita, Transitoria Natura Flammae, et Extinctio ejus Momentanea. Non enim videtur natura flammea hic apud nos figi et consistere, sed singulis quasi momentis generari, et statim extingui. Manifestum enim est in flammis, quae hic continuantur et durant, istam durationem non esse ejusdem flammae in individuo, sed fieri per successionem novae flammae seriatim generatae, minime autem manere eandem flammam numero; id quod facile perspicitur ex hoc, quod, subtracto alimento sive fomite flammae, flamma statim pereat. Bivium autem circa hanc naturam tale est. Momentanea ista natura aut fit remittente se causa quae eam primo genuit, ut in lumine, sonis, et motibus (quos vocant) violentis; aut quod flamma in natura sua possit hic apud nos manere, sed a contrariis naturis circumfusis vim patiatur et destruatur [15].

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[15] The extinction of a flame is, of course, due to the supply of one or other of the gases, by the combination of which it is produced, being cut off. So far is atmospheric air from being inimical to flame that, in by very far the great majority of cases, the oxygen which is contained in air is one of the gases by the combination of which flame is generated. At the same time, when oxygen is carried to the very heart of a flame, it instantly consumes the other gas, and so may extinguish the flame by destroying one of its constituents.

On the nature of Flame (of which Bacon was quite ignorant), see Tyndall's Heat a Mode of Motion, 2nd Ed., § 49, &c., or Watts' Dictionary of Chemistry, article 'Combustion.'

Itaque poterit esse circa hoc subjectum *instantia crucis* talis. Videmus flammas in incendiis majoribus, quam alte in sursum ascendant. Quanto enim basis flammae est latior, tanto vertex sublimior. Itaque videtur principium extinctionis fieri circa latera, ubi ab aëre flamma comprimitur et male habetur. At meditullia flammae, quae aër non contingit sed alia flamma undique circumdat, eadem numero manent, neque extinguuntur donec paulatim angustientur ab aëre per latera circumfuso. Itaque omnis flamma pyramidalis est basi circa fomitem largior, vertice autem (inimicante aëre, nec suppeditante fomite) acutior. At fumus angustior circa basin ascendendo dilatatur, et fit tanquam pyramis inversa; quia scilicet aër fumum recipit, flammam (neque enim quispiam somniet aërem esse flammam accensam, cum sint corpora plane heterogenea[16]) comprimit[17].

Accuratior autem poterit esse *instantia crucis* ad hanc rem accommodata, si res forte manifestari possit per flammas bicolores. Capiatur igitur situla parva ex metallo, et in ea figatur parva candela cerea accensa; ponatur situla in patera, et circumfundatur spiritus vini in modica quantitate, quae ad labra situlae non attingat; tum accende spiritum vini. At spiritus ille vini exhibebit flammam magis scilicet caeruleam, lychnus candelae autem magis flavam. Notetur itaque utrum flamma lychni (quam facile est per colorem a flamma spiritus vini distinguere; neque enim flammae, ut liquores, statim commiscentur) maneat pyramidalis, an potius magis tendat ad formam globosam, cum nihil inveniatur quod eam destruat

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[16] Here we may observe the influence of the old doctrine of the four elements, of which air and fire were two.

[17] The pyramidal form of flame is due to the fact that, while one of its constituents (oxygen) is equally diffused, the other has a definite source. The nearer this latter (which, in its pure condition, constitutes the 'unburnt core') is to its source, the larger is its volume; for the further it recedes from its source, the larger is the amount of it which is consumed. Smoke, on the other hand, not entering into combination or conflict with any other body, is able to diffuse itself freely, and, hence, assumes the form described in the text. In a certain sense, therefore, Bacon is right in ascribing the form of flame to its contact with the surrounding air.

aut comprimat[18]. At hoc posterius si fiat, manere flammam eandem numero, quamdiu intra aliam flammam concludatur nec vim inimicam aëris experiatur, pro certo ponendum est.

Atque de *instantiis crucis* haec dicta sint. Longiores autem in iis tractandis ad hunc finem fuimus, ut homines paulatim discant et assuefiant de natura judicare per *instantias crucis* et experimenta lucifera, et non per rationes probabiles[19].

XXXVII.

Inter *praerogativas instantiarum* ponemus loco decimo quinto *Instantias Divortii;* quae indicant separationes naturarum earum quae ut plurimum occurrunt[20]. Differunt autem ab instantiis quae subjunguntur *instantiis comitatus*[21]*;* quia illae indicant separationes naturae alicujus ab aliquo concreto cum quo illa familiariter consuescit, hae vero separationes naturae alicujus ab altera natura[22]. Differunt etiam ab *instantiis crucis;* quia nihil determinant, sed monent tantum de separa-

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[18] A full account of this experiment is given in Sylva Sylvarum, Exp. 31. Mr. Ellis there remarks: 'The explanation of this experiment is simply that in impure air flames increase in size because the heated vapour of which they are composed diffuses itself before it meets with sufficient oxygen for complete combustion.'

Bacon may, perhaps, be credited with having seen, in a dim sort of way, that air had some connection with flame, but the whole of this speculation, like the two preceding ones, is wide of the mark.

[19] Bacon, then, regarded these Instances as affording certainty, and, supposing the various alternatives to be stated exhaustively and the observations or experiments to be properly selected and rightly conducted, they would do so.

[20] I think that this must mean: 'which for the most part occur *together*.'

[21] The Instantiae Subjunctivae of Aph. 34.

[22] These instances seem to differ from the 'Instantiae Hostiles' of Aph. 33 only in form. There a 'nature' is adduced as 'hostile' to or dissociated from some particular kind of concrete body; here one 'nature' is adduced as dissociated in certain cases, or in certain kinds of bodies, from some other nature. But the difference seems to consist solely in the mode of stating the propositions, abstract terms or 'natures' being employed both in subject and predicate in the one case, and, in the other, an abstract term or 'nature' being denied of some concrete body.

It might be said, by way of suggesting a difference, that the 'Instantiae Divortii' are exceptions to general rules, but then the 'Instantiae Hostiles,' so far as we can make out from the examples, seem to have this character as well.

bilitate unius naturae ab altera. Usus autem earum est ad prodendas falsas formas, et dissipandas leves contemplationes ex rebus obviis orientes; adeo ut veluti plumbum et pondera intellectui addant[23].

Exempli gratia: sint naturae inquisitae quatuor naturae illae, quas *Contubernales* vult esse Telesius[24], et tanquam ex eadem camera; viz. calidum, lucidum, tenue, mobile sive promptum ad motum. At plurimae inveniuntur *instantiae divortii* inter ipsas. Aër enim tenuis est et habilis ad motum, non calidus aut lucidus; luna lucida, absque calore; aqua fervens calida, absque lumine; motus acus ferreae super versorium pernix et agilis, et tamen in corpore frigido, denso, opaco; et complura id genus.

Similiter sint naturae inquisitae Natura Corporea et Actio Naturalis. Videtur enim non inveniri actio naturalis, nisi subsistens in aliquo corpore. Attamen possit fortasse esse circa hanc rem *instantia* nonnulla *divortii*. Ea est actio magnetica, per quam ferrum fertur ad magnetem, gravia ad globum terrae[25]. Addi etiam possint aliae nonnullae operationes ad distans. Actio siquidem hujusmodi et in tempore

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[23] Cp. i. 104.

[24] See Telesius, De Rerum Natura, passim; especially lib. i. capp. 1, 2. Thus, of the Sun, he says: 'omnino calidus, tenuis, candidus, mobilisque est Sol: Terra contra, frigida, crassa, immobilis, tenebricosaque.'

[25] Cp. last Aphorism, Example (3), where, on the other hand, he seems to distinguish between magnetic attraction and the attraction exercised by the earth.

Bacon's idea appears to have been that magnetism and terrestrial attraction (which he here speaks of as if they were the same) act without affecting the intermediate bodies (air, ether, or whatever they may be); that they act in time; and, hence, that 'the natural action' or 'virtue' is, as it were, for a while suspended between the acting body and the body acted upon. From this he infers that 'natural action' may be detached from any 'corporeal nature.'

The manner in which gravitation acts is still unknown. We know the fact and the law, but all the rest is mere matter of speculation. Whether the force does or does not require a material medium for its propagation, and whether it is or is not transmitted in time, are questions which have not yet been resolved and which, perhaps, admit of no solution. It was calculated by Laplace that, if its velocity be measurable at all, it must be, at least, fifty millions of times greater than the velocity of light. As to the medium, though there are grounds for believing in the existence of a subtle

fit, per momenta non in puncto temporis, et in loco, per gradus et spatia. Est itaque aliquod momentum temporis, et aliquod intervallum loci, in quibus ista virtus sive actio haeret in medio inter duo illa corpora quae motum cient. Reducitur itaque contemplatio ad hoc; utrum illa corpora quae sunt termini motus disponant vel alterent corpora media, ut per successionem et tactum verum labatur virtus a termino ad terminum, et interim subsistat in corpore medio; an horum nihil sit, praeter corpora et virtutem et spatia? Atque in radiis opticis et sonis et calore et aliis nonnullis operantibus ad distans, probabile est media corpora disponi et alterari [26]: eo magis, quod requiratur medium qualificatum ad deferendam operationem talem. At magnetica illa sive coitiva virtus admittit media tanquam adiaphora, nec impeditur virtus in omnigeno medio. Quod si nil rei habeat virtus illa aut actio cum corpore medio, sequitur quod sit virtus aut actio naturalis ad tempus nonnullum et in loco nonnullo subsistens sine corpore; cum neque subsistat in corporibus terminantibus, nec in mediis. Quare actio magnetica poterit esse *instantia divortii* circa naturam corpoream et actionem naturalem. Cui hoc adjici potest tanquam corollarium aut lucrum non praetermittendum: viz. quod etiam secundum sensum philosophanti [27] sumi possit probatio quod sint entia et substantiae separatae et incorporeae [28]. Si enim virtus et actio

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and elastic ether pervading all space, there is no positive evidence for connecting with this medium the phenomena of gravitation.

Similarly, there is no evidence to shew whether magnetic and electrical *attraction* require time for their transmission, and a medium in which to act. The velocity of *conducted* electricity has been calculated, for various media, by Wheatstone and others. See Ganot's Physics, 8th Ed. of Transl., § 771.

[26] Bacon ought, perhaps, to have some credit for having so far divined the conditions of the action of heat, light, and sound.

[27] That is, even to the Natural Philosopher. The same expression occurs, and I think in the same sense, in De Augm. iv. 3 ad init. (E. and S., vol. i. p. 605).

[28] The reasoning by which Bacon arrives at this conclusion is, it must be confessed, of a very fanciful character, and, in fact, the whole of this discussion is marked by an excess of subtlety with which we do not often meet in Bacon's writings. As to the conclusion itself, it is of some importance as bearing on the *quaestio vexata* of Bacon's theological views. Cp. Locke's Essay, bk. iv. ch. 10. § 19: 'We cannot conceive how anything

naturalis, emanans a corpore, subsistere possit aliquo tempore et aliquo loco omnino sine corpore; prope est ut possit etiam emanare in origine sua a substantia incorporea. Videtur enim non minus requiri natura corporea ad actionem naturalem sustentandam et devehendam, quam ad excitandam aut generandam.

XXXVIII.

Sequuntur quinque ordines *instantiarum*, quas uno vocabulo generali *Instantias Lampadis*[29] sive *Informationis Primae* appellare consuevimus. Eae sunt quae auxiliantur sensui. Cum enim omnis *interpretatio naturae* incipiat a sensu[30], atque a sensuum perceptionibus recta, constanti, et munita via ducat ad perceptiones intellectus, quae sunt notiones verae et axiomata; necesse est ut, quanto magis copiosae et exactae fuerint repraesentationes sive praebitiones ipsius sensus, tanto omnia cedant facilius et foelicius.

Harum autem quinque *instantiarum lampadis*, primae roborant, ampliant, et rectificant actiones sensus immediatas;

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but Impulse of Body can move body; and yet that is not a reason sufficient to make us deny it possible, against the constant experience we have of it in ourselves in all our voluntary motions, which are produced in us only by the free action or Thought of our own minds, and are not nor can be the effects of Impulse or Determination of the motion of blind matter in or upon our bodies. * * * 'Tis an over-valuing ourselves to reduce all to the narrow measure of our capacities; and to conclude all things impossible to be done, whose manner of doing exceeds our comprehension. This is to make our Comprehension infinite or God finite, when what he can do is limited to what we can conceive of it.' In bk. ii. ch. 23. § 32, and elsewhere, he maintains that it is 'no more a contradiction, that Thinking should exist separate and independent from Solidity, than it is a contradiction, that Solidity should exist separate and independent from Thinking * * * and, having as clear and distinct ideas in us of Thinking as of Solidity, I know not why we may not as well allow a thinking thing without Solidity, i. e. *immaterial*, to exist, as a solid thing without Thinking, i. e. *matter*, to exist.' Hobbes, on the other hand, regarded the expressions 'incorporeal spirit,' 'incorporeal substance,' &c., as contradictions in terms, and seems to have thought that they had no meaning, even when applied to God. See Leviathan, Part i. ch. 12, Part iii. ch. 34, and other places.

[29] The 'Instances' thus far described have for their office to assist the Understanding; the next five, called generically 'Instances of the Lamp,' serve to inform or supply the defects of the Senses.

[30] Cp. i. 1, 19, 69, &c.

secundae deducunt non-sensibile ad sensibile; tertiae indicant processus continuatos sive series earum rerum et motuum quae (ut plurimum) non notantur nisi in exitu aut periodis; quartae aliquid substituunt sensui in meris destitutionibus; quintae excitant attentionem sensus et advertentiam, atque una limitant subtilitatem rerum. De his autem singulis jam dicendum est.

XXXIX.

Inter *praerogativas instantiarum* ponemus loco decimo sexto *Instantias Januae* sive *Portae:* eo enim nomine eas appellamus quae juvant actiones sensus immediatas. Inter sensus autem manifestum est partes primas tenere Visum, quoad informationem; quare huic sensui praecipue auxilia conquirenda. Auxilia autem triplicia esse posse videntur: vel ut percipiat non visa; vel ut majore intervallo; vel ut exactius et distinctius.

Primi generis sunt (missis bis-oculis[31] et hujusmodi, quae valent tantum ad corrigendam et levandam infirmitatem visus non bene dispositi, atque ideo nihil amplius informant) ea quae nuper inventa sunt perspicilla[32]; quae latentes et invisibiles corporum minutias, et occultos schematismos et motus (aucta insigniter specierum magnitudine) demonstrant; quorum vi, in pulice, musca, vermiculis, accurata corporis figura et lineamenta, necnon colores et motus prius non conspicui, non sine admiratione cernuntur. Quinetiam aiunt lineam rectam calamo vel penecillo descriptam, per hujusmodi per-

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[31] Spectacles. Their invention, like that of the Microscope and Telescope, has been ascribed to Roger Bacon. But, however this may be (and there are many other claimants), it is pretty clear that the invention is due to the end of the thirteenth century. See Encyclopaedia Britannica, art. on Optics.

[32] Microscopes. It seems plain from the context that Bacon had not seen one. He speaks of them as lately invented. Supposing Roger Bacon to have described rather what he thought might be than what actually was constructed, we may, perhaps, refer the actual invention of microscopes to Zacharias Jansen of Middleburg, about 1590. 'Jansen gave one of his microscopes to the Archduke, who gave it to Cornelius Drebbel, a salaried mathematician at the court of our James I.' See Life of Galileo, ch. 6, in Library of Useful Knowledge. See also Enc. Br., art. on Optics; Montucla, Histoire des Mathématiques, Part iv. liv. iv.

spicilla inaequalem admodum et tortuosam cerni: quia scilicet nec motus manus, licet per regulam adjutae, nec impressio atramenti aut coloris revera aequalia existant; licet illae inaequalitates tam minutae sint ut sine adjumento hujusmodi perspicillorum conspici nequeant. Etiam superstitiosam quandam observationem in hac re (ut fit in rebus novis et miris) addiderunt homines: viz quod hujusmodi perspicilla opera naturae illustrent, artis dehonestent. Illud vero nihil aliud est quam quod texturae naturales multo subtiliores sint quam artificiosae. Perspicillum enim illud ad minuta tantum valet: quale perspicillum si vidisset Democritus, exiluisset forte, et modum videndi atomum (quem ille invisibilem [33] omnino affirmavit) inventum fuisse putasset. Verum incompetentia hujusmodi perspicillorum, praeterquam ad minutias tantum (neque ad ipsas quoque, si fuerint in corpore majusculo), usum rei destruit. Si enim inventum extendi posset ad corpora majora [34], aut corporum majorum minutias, adeo ut textura panni lintei conspici posset tanquam rete, atque hoc modo minutiae latentes et inaequalitates gemmarum, liquorum, urinarum, sanguinis, vulnerum, et multarum aliarum rerum, cerni possent [35], magnae proculdubio ex eo invento commoditates capi possent.

Secundi generis sunt illa altera perspicilla [36] quae memo-

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[33] Aristotle (De Generatione et Corruptione, i. 8), speaking of Leucippus, says: *ἀλλ' εἶναι τὸ τοιοῦτον οὐχ ἕν, ἀλλ' ἄπειρα τὸ πλῆθος καὶ ἀόρατα διὰ σμικρότητα τῶν ὄγκων.*

[34] This object is effected by means of the solar microscope.

[35] Cp. New Atlantis (E. and S., vol. iii. p. 162). It is needless to say that, with modern microscopes of high magnifying power, this is the case.

[36] Telescopes. The merit of the invention of these instruments has been more hotly disputed than even that of single lenses and microscopes. A very interesting popular account of the controversy is given in the Life of Galileo above referred to, and the student may also consult the article on Optics in the Encyclopaedia Britannica, and Montucla, Histoire des Mathématiques, Pt. iv. liv. iv. Delambre disposes of the claims of Fracastorius, Astronomie du Moyen Age, tome i. pp. 388–9.

Though Galileo was not the actual inventor of the Telescope, he seems to have been the first who turned it to scientific uses, and it was, undoubtedly, through his discoveries by means of it that it first became celebrated. For a long time, also, the best telescopes were only to be procured from Galileo or his scholars. The first telescope constructed by him was presented to the Doge of Venice in 1609.

rabili conatu adinvenit Galilaeus; quorum ope, tanquam per scaphas aut naviculas, aperiri et exerceri possint propiora cum coelestibus commercia [37]. Hinc enim constat, galaxiam esse nodum sive coacervationem stellarum parvarum, plane numeratarum et distinctarum; de qua re apud antiquos tantum suspicio fuit [38]. Hinc demonstrari videtur, quod spatia orbium (quos vocant) planetarum non sint plane vacua aliis stellis, sed quod coelum incipiat stellescere antequam ad coelum ipsum stellatum ventum sit; licet stellis minoribus quam ut

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[37] 'Compare this with the passage in the Descriptio Globi Intellectualis (c. v.) where Bacon speaks of Galileo's invention and discoveries (the first-fruits of which had just been announced) in a strain of more sanguine expectation: "Atque hoc inceptum et fine et aggressu nobile quoddam et humano genere dignum esse existimamus: eo magis quod hujusmodi homines et ausu laudandi sint et fide; quod ingenue et perspicue proposuerunt, quomodo singula illis constiterint. Superest tantum constantia, cum magna judicii severitate, ut et instrumenta mutent, et testium numerum augeant, et singula et saepe experiantur, et varie; denique ut et sibi ipsi objiciant et aliis patefaciant quid in contrarium objici possit, et tenuissimum quemque scrupulum non spernant; ne forte illis eveniat, quod Democriti et aniculae suae evenit circa ficus mellitas, ut vetula esset philosopho prudentior, et magnae et admirabilis speculationis causae subesset error quispiam tenuis et ridiculus." From this passage, written eight years before, we may learn (I think) why it was that Bacon had now begun to doubt how far these observations could be trusted. Believing, as he did, that all the received theories of the heavens were full of error, as soon as he heard that by means of the telescope men could really see so much further into the heavens than before, he was prepared to hear of a great number of new and unexpected phenomena; and his only fear was that the observers, instead of following out their observations patiently and carefully, would begin to form new theories. But now that nine years had passed since the discovery of Jupiter's satellites, the spots in the sun, &c., and no new discovery of importance had been announced, he wondered how it could be that men seeing so much further should be able to see so little more than they did, and began to suspect that it was owing to some defect either in the instrument or in the methods of observation.' This note I have borrowed from Mr. Spedding.

[38] See Mullach, Democriti Fragmenta, p. 391. Amongst other authors he quotes Stobaeus, Ecl. Phys. p. 576: *Δημόκριτος (τὸ γάλα ἔφη εἶναι) πολλῶν καὶ μικρῶν καὶ συνεχῶν ἀστέρων, συμφωτιζομένων ἀλλήλοις, διὰ τὴν πύκνωσιν, συναυγασμόν.* Cp. Arist. Meteor. i. 8 (p. 345 a), where the same opinion is also attributed to Anaxagoras and his followers. See also Manilius, i. 725–32; Ovid, Met. i. 168, &c.

Democritus also maintained that the moon is a solid body, and that the marks on its face represent mountains and valleys.

sine perspicillis istis conspici possint. Hinc choreas illas stellarum parvarum circa planetam Jovis (unde conjici possit esse in motibus stellarum plura centra) intueri licet. Hinc inaequalitates luminosi et opaci in luna distinctius cernuntur et locantur; adeo ut fieri possit quaedam seleno-graphia. Hinc maculae in sole, et id genus [39]: omnia certe inventa nobilia, quatenus fides hujusmodi demonstrationibus tuto adhiberi possit [40]. Quae nobis ob hoc maxime suspectae sunt, quod in istis paucis sistatur experimentum, neque alia complura investigatu aeque digna eadem ratione inventa sint.

Tertii generis sunt bacilla illa ad terras mensurandas, astrolabia [41], et similia; quae sensum videndi non ampliant, sed rectificant et dirigunt. Quod si sint aliae instantiae quae reliquos sensus juvent in ipsorum actionibus immediatis et individuis, tamen si ejusmodi sint quae informationi ipsi nihil

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[39] On these various discoveries, the last of which was also claimed by the monk Scheiner, see Delambre, Histoire de l'Astronomie Moderne, tome i. liv. vi, and Mr. Drinkwater's Life of Galileo, printed in the Library of Useful Knowledge, above referred to.

[40] Galileo's discoveries were often represented as mere optical delusions. The following amusing story is told of Scheiner (Baden Powell's History of Natural Philosophy, p. 171): 'Scheiner was a monk; and, on communicating to the superior of his order the account of the spots, received in reply from that learned father a solemn admonition against such heretical notions: "I have searched through Aristotle," he said, "and can find nothing of the kind mentioned: be assured, therefore, that it is a deception of your senses, or of your glasses."' One Lodovico delle Colombe maintained that the apparently hollow parts of the moon were filled with pure transparent crystal, to which Galileo replied that he would gladly admit the theory, provided that, with equal courtesy, he was allowed to raise on the smooth surface crystal mountains ten times higher than those which he had ever seen and measured.

[41] These were astronomical instruments, used for the purpose of 'taking' or observing the stars. 'The ancient astrolabe consisted of two or more circles, having a common centre, and so inclined to each other as to enable the astronomer to observe in the planes of different circles of the sphere at the same time. For example, if the circles were at right angles, the instrument would give both longitude and latitude, or the right ascension and declination of a star. The equatorial, the altitude and azimuth instrument, and the theodolite, are instruments which answer the same purpose as the ancient astrolabe.' Brande and Cox's Dictionary of Science, &c. The term astrolabe is also employed to denote a planisphere.

addant plus quam jam habetur, ad id quod nunc agitur non faciunt. Itaque earum mentionem non fecimus.

XL.

Inter *praerogativas instantiarum* ponemus loco decimo septimo *Instantias Citantes*[42], sumpto vocabulo a foris civilibus, quia citant ea ut compareant quae prius non comparuerunt; quas etiam *Instantias Evocantes* appellare consuevimus. Eae deducunt non-sensibile ad sensibile.

Sensum autem fugiunt res, vel propter distantiam objecti locati[43]; vel propter interceptionem sensus per corpora media; vel quia objectum non est habile ad impressionem in sensu faciendam; vel quia deficit quantum in objecto pro feriendo sensu; vel quia tempus non est proportionatum ad actuandum sensum; vel quia objecti percussio non toleratur a sensu; vel quia objectum ante implevit et possedit sensum, ut novo motui non sit locus. Atque haec praecipue ad visum pertinent, et deinde ad tactum. Nam hi duo sensus sunt informativi ad largum, atque de communibus objectis[44]; ubi reliqui tres non informent fere, nisi immediate et de propriis objectis.

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[42] 'The *instantiae citantes* enable us to perceive things which are in themselves insensible, or not at all the objects of perception. They cite or place things, as it were, before the bar of the senses, and from this analogy to judicial proceedings is derived the name of *instantiae citantes*. Such, to employ examples which the progress of science has unfolded since the time of Bacon, are the air-pump and the barometer for manifesting the weight and elasticity of air; the measurement of the velocity of light, by means of the eclipses of the satellites of Jupiter, and the aberration of the fixed stars; the experiments in electricity and galvanism, and in the greater part of pneumatic chemistry. In all these instances things are made known which before had entirely escaped the senses.' Playfair's Preliminary Dissertation.

[43] The first and fourth of these cases are, at first sight, hardly distinguishable from the 'Instantiae Januae.' But, when we come to the examples, we find that Bacon has in mind objects which cannot be known in themselves but can be known only by means of indications, whereas in the 'Instantiae Januae' the objects themselves can be detected, provided we have sufficiently powerful instruments.

[44] The impressions of sight and touch are so intimately associated, that, in most cases, one is an index of the other. The student will not fail to recall, in connection with this subject, Berkeley's New Theory of Vision as applied to the acquired perceptions of Sight and the numerous kindred

(1) In primo genere non fit deductio ad sensibile, nisi rei, quae cerni non possit propter distantiam, adjiciatur aut substituatur alia res quae sensum magis e longinquo provocare et ferire possit: veluti in significatione rerum per ignes, campanas, et similia [45].

(2) In secundo genere fit deductio, cum ea quae interius propter interpositionem corporum latent, nec commode aperiri possunt, per ea quae sunt in superficie, aut ab interioribus effluunt, perducuntur ad sensum: ut status humanorum corporum per pulsus, et urinas, et similia [46].

(3, 4) At tertii et quarti generis [47] deductiones ad plurima spectant, atque undique in rerum inquisitione sunt conquirendae. Hujus rei exempla sunt. Patet quod aër, et spiritus, et hujusmodi res quae sunt toto corpore tenues et subtiles, nec cerni nec tangi possint. Quare in inquisitione circa hujusmodi corpora deductionibus omnino est opus.

Sit itaque natura inquisita Actio et Motus Spiritus qui includitur in corporibus tangibilibus [48]. Omne enim tangibile

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theories, doubtless suggested by it, which have been applied in recent times to the elucidation of some of the more obscure problems of psychology.

[45] A 'glaring instance' will, of course, suggest itself in the Electric Telegraph.

[46] Mr. Kitchin instances the Stethescope.

'An excellent instance of the "deductio non-sensibilis ad sensibile" occurs in the experiments recently made by Messrs. Hopkins and Joule for determining the melting-point of substances subjected to great pressure. The substance acted on is enclosed in a tube out of reach and sight. But a bit of magnetised steel has previously been introduced into it, and is supported by it as long as it remains solid. A magnetic needle is placed beside the apparatus, a certain amount of deviation being, of course, produced by the steel within the tube. The moment the temperature reaches the melting-point, the steel sinks; and its doing so is indicated by the motion of the needle.' Mr. Ellis' note.

[47] Of the third kind Mr. Kitchin gives good instances in the chemical detection of gases, and the discovery of Actinism in rays of the sun by exposure of a plate of silver to them. The microscope (see note 43 above) is not an appropriate instance of the fourth kind. But we might find a good instance in the thermometer (which Bacon himself gives), or a still better one in the thermo-electric pile, as *indicating* small accessions of temperature, inappreciable to the senses. Tests of all kinds, as Bacon observes, fall under one or other of these heads.

[48] Cp. i. 50, ii. 7, 13 (Inst. 38), 27, 50 (modus tertius). Bacon constantly recurs also in his other works to the idea of 'Spirit,' its various

apud nos continet spiritum invisibilem et intactilem, eique obducitur atque eum quasi vestit. Hinc fons triplex potens ille et mirabilis processus spiritus in corpore tangibili. Spiritus enim in re tangibili, emissus, corpora contrahit et desiccat; detentus, corpora intenerat et colliquat; nec prorsus emissus nec prorsus detentus, informat, membrificat, assimilat, egerit, organizat, et similia. Atque haec omnia deducuntur ad sensibile per effectus conspicuos.

Etenim in omni corpore tangibili inanimato, spiritus inclusus primo multiplicat se, et tanquam depascit partes tangibiles eas quae sunt maxime ad hoc faciles et praeparatae, easque digerit et conficit et vertit in spiritum, et deinde una evolant. Atque haec confectio et multiplicatio spiritus deducitur ad sensum per diminutionem ponderis. In omni enim desiccatione, aliquid defluit de quanto; neque id ipsum ex spiritu tantum praeinexistente, sed ex corpore quod prius fuit tangibile et noviter versum est: spiritus enim non ponderat. Egressus autem sive emissio spiritus deducitur ad sensibile in rubigine[49] metallorum, et aliis putrefactionibus ejus generis quae sistunt se antequam pervenerint ad rudimenta vitae; nam illae[50] ad tertium genus processus pertinent. Etenim in corporibus magis compactis spiritus non invenit poros et meatus per quos evolet: itaque cogitur partes ipsas tangibiles protrudere et ante se agere, ita ut illae simul exeant; atque inde fit rubigo, et similia. At contractio partium tangibilium, post-

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kinds, its operations, its effects, &c. See especially Sylva Sylvarum, Exp. 98 (E. and S., vol. ii. pp. 380–82); Historia Vitae et Mortis (E. and S., vol. ii. pp. 213–21); Historia Densi et Rari (E. and S., vol. ii. pp. 254–6). In a note on i. 50, I have commented at some length on Bacon's conception of Spirit. See also the notes on ii. 13 (Inst. 38) and 27. This antiquated piece of Physics or Metaphysics, it would be superfluous to annotate in detail. The reader will easily be able to notice for himself the more curious parts of the disquisition which follows.

It may be remarked that, though Bacon's account of 'Spirit' does not seem to be taken directly, at least without considerable modifications, from Paracelsus, there is much in common between the speculations of the two writers on this subject. I have not, however, thought it worth while to point this out in detail.

[49] Rust proper is due to the combination of iron with oxygen. Iron, as well as many other metals, becomes oxidised by exposure to moist air.

[50] This, as Mr. Ellis suggests, should be illa.

quam aliquid de spiritu fuerit emissum (unde sequitur illa desiccatio), deducitur ad sensibile tum per ipsam duritiem rei auctam, tum multo magis per scissuras, angustiationes, corrugationes, et complicationes corporum, quae inde sequuntur. Etenim partes ligni desiliunt et angustiantur; pelles corrugantur; neque id solum, sed (si subita fuerit emissio spiritus per calorem ignis) tantum properant ad contractionem ut se complicent et convolvant.

At contra, ubi spiritus detinetur, et tamen dilatatur et excitatur per calorem aut ejus analoga (id quod fit in corporibus magis solidis aut tenacibus), tum vero corpora emolliuntur, ut ferrum candens; fluunt, ut metalla; liquefiunt, ut gummi, cera, et similia. Itaque contrariae illae operationes caloris (ut ex eo alia durescant [51], alia liquescant) facile conciliantur; quia in illis spiritus emittitur, in his agitatur et detinetur: quorum posterius est actio propria caloris et spiritus; prius, actio partium tangibilium tantum per occasionem spiritus emissi.

Ast ubi spiritus nec detinetur prorsus nec prorsus emittitur, sed tantum inter claustra sua tentat et experitur, atque nacta est partes tangibiles obedientes et sequaces in promptu, ita ut quo spiritus agit eae simul sequantur; tum vero sequitur efformatio in corpus organicum, et membrificatio, et reliquae actiones vitales, tam in vegetabilibus quam in animalibus.

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[51] The hardening produced by heat is due to the escape of moisture or to some chemical change in the substance.

Cp. Lucretius, vi. 959, &c.:

> 'Huc accedit uti non omnia, quae jaciuntur
> Corpora cumque ab rebus, eodem praedita sensu
> Atque eodem pacto rebus sint omnibus apta.
> Principio terram sol excoquit et facit are,
> At glaciem dissolvit et altis montibus altas
> Extructasque nives radiis tabescere cogit.
> Denique cera liquefit in ejus posta vapore.
> Ignis item liquidum facit aes aurumque resolvit,
> At coria et carnem trahit et conducit in unum.
> Umor aquae porro ferrum condurat ab igni,
> At coria et carnem mollit durata calore.'

Virg. Ecl. viii. 80:

> 'Limus ut hic durescit, et haec ut cera liquescit
> Uno eodemque igni, sic nostro Daphnis amore.'

Atque haec maxime deducuntur ad sensum per notationes diligentes primorum incoeptuum et rudimentorum sive tentamentorum vitae in animalculis ex putrefactione natis: ut in ovis formicarum, vermibus, muscis, ranis post imbrem, &c. Requiritur autem ad vivificationem et lenitas caloris et lentor corporis; ut spiritus nec per festinationem erumpat, nec per contumaciam partium coerceatur, quin potius ad cerae modum illas plicare et effingere possit.

Rursus, differentia illa spiritus, maxime nobilis et ad plurima pertinens (viz. spiritus abscissi, ramosi simpliciter, ramosi simul et cellulati; ex quibus prior est spiritus omnium corporum inanimatorum, secundus vegetabilium, tertius animalium), per plurimas instantias deductorias tanquam sub oculos ponitur.

Similiter patet, quod subtiliores texturae et schematismi rerum (licet toto corpore visibilium aut tangibilium) nec cernantur nec tangantur. Quare in his quoque per deductionem procedit informatio. At differentia schematismorum maxime radicalis et primaria sumitur ex copia vel paucitate materiae quae subit idem spatium sive dimensum. Reliqui enim schematismi (qui referuntur ad dissimilaritates partium, quae in eodem corpore continentur, et collocationes ac posituras earundem) prae illo altero sunt secundarii.

Sit itaque natura inquisita Expansio sive Coitio Materiae in corporibus respective: viz. quantum materiae impleat quantum dimensum in singulis. Etenim nil verius in natura quam propositio illa gemella, *ex nihilo nihil fieri*, neque *quicquam in nihilum redigi:* verum quantum ipsum materiae sive summam totalem constare, nec augeri aut minui [52]. Nec illud minus

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[52] This law is now known as that of the Indestructibility of Matter. Parallel to it, if not identical with it, is the law of the Conservation of Force. These are at once amongst the highest generalisations and amongst the most illuminating principles of Science. Mr. Bain gives an excellent summary of the various aspects and consequences of the Law of Conservation of Force in his Inductive Logic, 1st Ed., p. 20, &c. (cp. p. 225, &c.), but, perhaps, the best and most instructive exemplification of it is to be found in Sir W. R. Grove's Correlation of Physical Forces.

The maxim in the form in which Bacon gives it is of venerable antiquity. Thus Diogenes Laertius (ix. 44) recounting the opinions of Democritus, says: *μηδέν τε ἐκ τοῦ μὴ ὄντος γίνεσθαι, μηδὲ εἰς τὸ μὴ ὂν φθείρεσθαι* (cp.

verum, *ex quanto illo materiae sub iisdem spatiis sive dimensionibus, pro diversitate corporum, plus et minus contineri* [53]: ut in aqua plus, in aëre minus; adeo ut si quis asserat aliquod contentum aquae in par contentum aëris verti posse, idem sit ac si dicat aliquid posse redigi in nihilum; contra, si quis asserat aliquod contentum aëris in par contentum aquae verti posse, idem sit ac si dicat aliquid posse fieri ex nihilo. Atque ex copia ista et paucitate materiae notiones illae *densi* et *rari*, quae varie et promiscue accipiuntur, proprie abstrahuntur. Assumenda est et assertio illa tertia, etiam satis

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Plutarch, Adversus Colotem, Ed. Reiske, vol. x. p. 569). The same dictum is ascribed to Diogenes of Apollonia (Diog. Laert. ix. 57). Aristotle and others repeat it. *εἰ γὰρ πᾶν μὲν τὸ γινόμενον ἀνάγκη γίνεσθαι ἢ ἐξ ὄντων ἢ ἐκ μὴ ὄντων, τούτων δὲ τὸ μὲν ἐκ μὴ ὄντων γίνεσθαι ἀδύνατον (περὶ γὰρ ταύτης ὁμογνωμοῦσι τῆς δόξης ἅπαντες οἱ περὶ φύσεως), τὸ λοιπὸν ἤδη, κ.τ.λ.* Arist. Phys. i. 4 (p. 187 a. 32–35).

'Principium cujus' (sc. naturae) 'hinc nobis exordia sumet,
Nullam rem e nilo gigni divinitus unquam.
* * * * * * * * * * *
Quas ob res ubi viderimus nil posse creari
De nilo, tum quod sequimur jam rectius inde
Perspiciemus, et unde queat res quaeque creari
Et quo quaeque modo fiant opera sine divom.'

Lucretius, i. 149–158.

'Gigni
De nihilo nihilum, in nihilum nil posse reverti.'

Persius, Sat. iii. 83–4.

οὐδὲν γὰρ ἐκ τοῦ μηδενὸς ἔρχεται, ὥσπερ μηδ' εἰς τὸ οὐκ ὂν ἀπέρχεται.

Marcus Antoninus, iv. 4.

Telesius, De Rerum Natura, i. 5 (referred to by Mr. Ellis) says: 'Nihil tamen ejus' (sc. materiae) 'moles, itaque nec mundi magnitudo imminui augerive apparet unquam.'

[53] Both on this and the last proposition, cp. Historia Densi et Rari, Aditus (E. and S., vol. ii. pp. 243–4). The maxim 'Ex nihilo nihil fieri, neque quicquam in nihilum redigi' is there stated somewhat differently: 'Non scilicet fieri in aliqua transmutatione corporum transactionem aut a nihilo, aut ad nihilum; sed opera esse ejusdem omnipotentiae, creare ex nihilo, et redigere in nihilum; ex cursu naturae vero hoc nunquam fieri. Itaque summa materiae totalis semper constat; nil additur, nil minuitur.' It will be noticed that this statement saves the maxim from any theological objection.

On the relation of Bacon's doctrine of density and rarity to that of Aristotle and the Peripatetics, see Mr. Ellis' Preface to the Historia Densi et Rari, pp. 234–7.

certa: quod hoc de quo loquimur plus et minus materiae in corpore hoc vel illo ad calculos (facta collatione) et proportiones exactas aut exactis propinquas reduci possit[54]. Veluti si quis dicat inesse in dato contento auri talem coacervationem materiae, ut opus habeat spiritus vini, ad tale quantum materiae aequandum, spatio vicies et semel majore quam implet aurum, non erraverit[55].

Coacervatio autem materiae et rationes ejus deducuntur ad sensibile per pondus. Pondus enim respondet copiae materiae, quoad partes rei tangibilis; spiritus autem, et ejus quantum ex materia, non venit in computationem per pondus; levat enim pondus potius quam gravat[56]. At nos hujus rei tabulam fecimus[57] satis accuratam; in qua pondera et spatia singulorum metallorum, lapidum praecipuorum, lignorum, liquorum, oleorum, et plurimorum aliorum corporum tam naturalium quam artificialium, excepimus: rem polychrestam, tam ad lucem informationis quam ad normam operationis; et quae multas res revelet omnino praeter expectatum. Neque illud pro minimo habendum est, quod demonstret omnem varietatem quae in corporibus tangibilibus nobis notis versatur (intelligimus autem corpora bene unita, nec plane spongiosa et cava et magna ex parte aëre impleta) non ultra rationes

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[54] He makes an attempt to do this in the Table given in the Historia Densi et Rari (E. and S., vol. ii. pp. 245–6).

[55] In the Historia Densi et Rari (E. and S., vol. ii. pp. 245–6) he makes the ratio as 20 Den. 0 Gr. : 0 Den. 22 Gr. The true ratio of the Specific Gravity of Stamped Gold to Absolute Alcohol is 19.362 : 0.803 or about 24.2 : 1, while that of Cast Gold is 19.258 : 0.803 or about 24.07 : 1.

[56] This remark must apply to the 'spiritus vivi,' which are peculiar to living creatures, and not to the 'spiritus crudi,' which are present in every tangible substance; for in the Historia Densi et Rari (E. and S., vol. ii. p. 256), and elsewhere, he speaks of the 'spiritus crudi' as denser than air, which he regarded as having neither weight nor levity ('diligenter experti sumus, aerem ad minuendum aut sublevandum pondus nihil conferre'), whereas the 'spiritus vivi' are 'aere ipso aliquanto rariores,' and are, therefore, endowed with positive levity. 'Videtur aer pondus non minuere; spiritus autem vivus hoc facere. Atque cum pondus densitates dijudicet, etiam levatio ponderis raritates dijudicare debet.' The whole passage is exceedingly curious. On the notion that air has no weight, cp. Sylva Sylvarum, Exp. 29 (E. and S., vol. ii. pp. 350–1).

[57] The Table referred to above in note 54.

partium 21 excedere[58]: tam finita scilicet est natura, aut saltem illa pars ejus cujus usus ad nos maxime pertinet.

Etiam diligentiae nostrae esse putavimus, experiri si forte capi possint rationes corporum non-tangibilium sive pneumaticorum, respectu corporum tangibilium. Id quod tali molitione aggressi sumus. Phialam vitream[59] accepimus, quae unciam fortasse unam capere possit; parvitate vasis usi, ut minori cum calore posset fieri evaporatio sequens. Hanc phialam spiritu vini implevimus fere ad collum; eligentes spiritum vini, quod per tabulam priorem eum esse ex corporibus tangibilibus (quae bene unita, nec cava sunt) rarissimum, et minimum continens materiae sub suo dimenso, observavimus. Deinde pondus aquae[60] cum phiala ipsa exacte notavimus. Postea vesicam accepimus, quae circa duas pintas contineret. Ex ea aërem omnem, quoad fieri potuit, expressimus eo usque ut vesicae ambo latera essent contigua: etiam prius vesicam oleo oblevimus cum fricatione leni, quo vesica esset clausior: ejus, si qua erat, porositate oleo obturata. Hanc vesicam circa os phialae, ore phialae intra os vesicae recepto, fortiter ligavimus; filo parum cerato, ut melius adhaeresceret et arctius ligaret. Tum demum phialam supra carbones ardentes in foculo collocavimus. At paulo post vapor sive aura spiritus vini, per calorem dilatati et in pneumaticum versi, vesicam paulatim sufflavit, eamque universam veli

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[58] The bodies arranged after 'spiritus vini' in the Table are probably regarded by him as 'spongiosa et cava,' &c. Platinum is heavier than Gold, and Ether lighter than Alcohol. The ratio of the Specific Gravity of rolled Platinum to that of Ether is 22.069 : 0.723 or about 30.5 : 1.

[59] Cp. Historia Densi et Rari, p. 257. The result of the experiment given there is that the vapour occupied more than 320 times as much space as the spirits themselves. The difference between the results of the two experiments is to be accounted for from the different temperatures of the vapours, the tension of a vapour increasing rapidly with the temperature, and, at the higher temperatures, in much larger ratios than the temperature itself.

In the Phaenomena Universi (E. and S., vol. iii. pp. 705–7) we have an account of the same experiment tried with water, and a comparison of the result with the result obtained from spirits of wine (p. 710).

[60] Unless 'aquae' be taken here in a very general sense, it must be a mistake for 'spiritus,' which word, I find, is substituted in the Oxford Edition of 1813.

instar undequaque extendit. Id postquam factum fuit, continuo vitrum ab igne removimus, et super tapetem posuimus ne frigore disrumperetur; statim quoque in summitate vesicae foramen fecimus, ne vapor, cessante calore, in liquorem restitutus resideret, et rationes confunderet. Tum vero vesicam ipsam sustulimus, et rursus pondus excepimus spiritus vini qui remanebat. Inde quantum consumptum fuisset in vaporem seu pneumaticum computavimus: et facta collatione quantum locum sive spatium illud corpus implesset quando esset spiritus vini in phiala, et rursus quantum spatium impleverit postquam factum fuisset pneumaticum in vesica, rationes subduximus: ex quibus manifeste liquebat, corpus istud ita versum et mutatum expansionem centuplo majorem quam antea habuisset acquisivisse.

Similiter sit natura inquisita Calor aut Frigus; ejus nempe gradus, ut a sensu non percipiantur ob debilitatem. Haec deducuntur ad sensum per vitrum calendare, quale superius descripsimus[61]. Calor enim et frigus, ipsa non percipiuntur ad tactum; at calor aërem expandit, frigus contrahit. Neque rursus illa expansio et contractio aëris percipitur ad visum; at aër ille expansus aquam deprimit, contractus attollit; ac tum demum fit deductio ad visum, non ante, aut alias.

Similiter sit natura inquisita Mistura Corporum: viz. quid habeant ex aqueo, quid ex oleoso, quid ex spiritu, quid ex cinere et salibus, et hujusmodi; vel etiam (in particulari) quid habeat lac butyri, quid coaguli, quid seri, et hujusmodi. Haec deducuntur ad sensum per artificiosas et peritas separationes, quatenus ad tangibilia. At natura spiritus in ipsis, licet immediate non percipiatur, tamen deprehenditur per varios motus et nixus corporum tangibilium in ipso actu et processu separationis suae; atque etiam per acrimonias, corrosiones, et diversos colores, odores, et sapores eorundem corporum post separationem. Atque in hac parte, per distillationes atque artificiosas separationes, strenue sane ab hominibus elaboratum est; sed non multo foelicius quam in caeteris experimentis, quae adhuc in usu sunt: modis nimirum prorsus palpatoriis, et viis caecis, et magis operose quam intelligenter; et (quod pes-

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[61] ii. 13 (38).

simum est) nulla cum imitatione aut aemulatione naturae [62], sed cum destructione (per calores vehementes aut virtutes nimis validas) omnis subtilioris schematismi, in quo occultae rerum virtutes et consensus praecipue sitae sunt. Neque illud etiam, quod alias monuimus [63], hominibus in mentem aut observationem venire solet in hujusmodi separationibus: hoc est, plurimas qualitates, in corporum vexationibus tam per ignem quam alios modos, indi ab ipso igne iisque corporibus quae ad separationem adhibentur, quae in composito prius non fuerunt; unde mirae fallaciae. Neque enim scilicet vapor universus, qui ex aqua emittitur per ignem, vapor aut aër antea fuit in corpore aquae; sed factus est maxima ex parte per dilatationem aquae ex calore ignis.

Similiter in genere omnes exquisitae probationes corporum sive naturalium sive artificialium, per quas vera dignoscuntur ab adulterinis, meliora a vilioribus, huc referri debent: deducunt enim non-sensibile ad sensibile. Sunt itaque diligenti cura undique conquirendae.

(5) Quintum vero genus latitantiae quod attinet, manifestum est actionem sensus transigi in motu, motum in tempore. Si igitur motus alicujus corporis sit vel tam tardus, vel tam velox, ut non sit proportionatus ad momenta in quibus transigitur actio sensus, objectum omnino non percipitur; ut in motu indicis horologii, et rursus in motu pilae sclopeti. Atque motus qui ob tarditatem non percipitur, facile et ordinario deducitur ad sensum per summas motus [64]; qui vero ob velocitatem,

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[62] Cp. the interesting passage in De Augmentis, v. 2 (E. and S., vol. i. pp. 627–8). The passage concludes with the sentence: 'Debuerant autem homines, si illis utilia inquirere vacaret, naturalia opificia et operationes singulas attente et minutim et ex composito intueri; et secum perpetuo et acriter cogitare, quaenam ex ipsis ad artes transferri possint. Speculum enim artis natura.'

[63] ii. 7. This remark shews that Bacon was fully aware of one of the principal sources of deception in experimentation; namely, that the employment of an abnormal process often itself introduces new conditions in the object under investigation.

[64] A good instance of this is the one given by Bacon, the hands of a clock. Still slower motions, which may be measured with tolerable accuracy, are the elevation or subsidence of continents, the advance or retreat of the sea, the gradual retreat of waterfalls, &c.

adhuc non bene mensurari consuevit; sed tamen postulat inquisitio naturae ut hoc fiat in aliquibus[65].

(6) Sextum autem genus, ubi impeditur sensus propter nobilitatem objecti, recipit deductionem, vel per elongationem majorem objecti a sensu; vel per hebetationem objecti per interpositionem medii talis, quod objectum debilitet, non annihilet[66]; vel per admissionem et exceptionem objecti reflexi, ubi percussio directa sit nimis fortis, ut solis in pelvi aquae.

(7) Septimum autem genus latitantiae, ubi sensus ita oneratur objecto ut novae admissioni non sit locus, non habet fere locum nisi in olfactu et odoribus[67]; nec ad id quod agitur multum pertinet. Quare de deductionibus non-sensibilis ad sensibile, haec dicta sint.

Quandoque tamen deductio fit non ad sensum hominis, sed ad sensum alicujus alterius animalis cujus sensus in aliquibus humanum excellet: ut nonnullorum odorum, ad sensum canis; lucis, quae in aëre non extrinsecus illuminato latenter existit, ad sensum felis, noctuae, et hujusmodi animalium quae cernunt noctu. Recte enim notavit Telesius[68], etiam in aëre ipso

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[65] This has now been effected in the case of light, sound, the motion of projectiles, electricity, &c. Perhaps the most magnificent example of the calculation of large velocities is to be found in the case of the velocity of light, which was computed on observations of the eclipses of Jupiter's satellites and confirmed by Bradley's discovery of the aberration of light. In recent times, Fizeau and Foucault have measured it by direct experiments.

[66] The use of ground or coloured glass would afford an instance of what Bacon means.

[67] Surely this is a defect common to all the senses. See Aph. 43 ad fin. We often cannot clearly distinguish objects in the glare of the sun; or hear sounds, while being whirled along in a coach or a railway carriage; or feel slight sensations of touch, while suffering great pain; or discriminate delicate flavours, while tasting something very pungent, acrid, or luscious. It is a well-known fact that the nicer and more delicate sensations are overpowered by those which are stronger or coarser in the same class.

[68] The passage referred to is the following: 'Nullum porro, nec infima, nec suprema coeli portio ad nos calorem, nullamque emittere videtur lucem: quod in longe utraque tenuissima perexilis inest calor, et qui nec proprias vires, nec propriam speciem valenter manifestare queat. At ab ipsis lucem quandam emanare, et quae, si non nobis, quibusdam certe animalium generibus percipiatur, quae longissima noctu conficiunt itinera declarant.' De Rerum Natura, i. 3. It seems plain to me, though Mr.

inesse lucem quandam originalem, licet exilem et tenuem, et maxima ex parte oculis hominum aut plurimorum animalium non inservientem; quia illa animalia, ad quorum sensum hujusmodi lux est proportionata, cernant noctu; id quod vel sine luce fieri, vel per lucem internam, minus credibile est.

Atque illud utique notandum est, de destitutionibus sensuum eorumque remediis hic nos tractare. Nam fallaciae sensuum ad proprias inquisitiones de sensu et sensibili [69] remittendae sunt: excepta illa magna fallacia sensuum, nimirum quod constituant lineas [70] rerum ex analogia hominis, et non ex analogia universi [71]; quae non corrigitur nisi per rationem et philosophiam universalem.

XLI.

Inter *praerogativas instantiarum* ponemus loco decimo octavo *Instantias Viae* [72], quas etiam *Instantias Itinerantes* et *Instantias Articulatas* appellare consuevimus. Eae sunt quae indicant naturae motus gradatim continuatos [73]. Hoc autem

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Ellis thinks it doubtful, that 'infima coeli portio' in this passage includes the air. Moreover, I think that in the exceedingly tedious discussion on Light in lib. iv, and elsewhere, it is implied that air is self-luminous; for air always contains some heat, and light is the concomitant of heat, 'cui inhaeret et cujus facies est.'

In the 'De Principiis atque Originibus,' Bacon gives an elaborate account of the opinions of Telesius, mentioning this amongst others. See E. and S., vol. iii. p. 106.

The curious idea that the air is self-luminous might have seemed to derive support not only from the habits of nocturnal and crepuscular animals, but also from the fact that it is hardly ever so dark in the open air but that some small amount of light is perceptible.

[69] Cp. De Augmentis, iv. 3 (E. and S., vol. i. pp. 610–13).

[70] Cp. i. 59: 'Verba autem plerunque ex captu vulgi induntur, atque per lineas, vulgari intellectui maxime conspicuas, res secant.'

[71] Cp. i. 41.

[72] It is difficult to distinguish between this class of instances and the 'Instantiae Migrantes' of ii. 23. We may, perhaps, say that the 'Instantiae viae' are propounded with reference to the preliminary process of observation, while the 'Instantiae migrantes' are propounded with reference to the subsequent processes of reasoning.

[73] It is, perhaps, needless to remind the reader of the Law of Continuity, with the many marvellous exemplifications of it afforded by recent observations and discoveries in Physics, Geology, Biology, &c., as well as in the sciences more immediately relating to the history and condition of man.

genus instantiarum potius fugit observationem quam sensum. Mira enim est hominum circa hanc rem indiligentia. Contemplantur siquidem naturam tantummodo desultorie et per periodos, et postquam corpora fuerint absoluta ac completa, et non in operatione sua [74]. Quod si artificis alicujus ingenia et industriam explorare et contemplari quis cuperet, is non tantum materias rudes artis atque deinde opera perfecta conspicere desideraret, sed potius praesens esse cum artifex operatur et opus suum promovet. Atque simile quiddam circa naturam faciendum est. Exempli gratia; si quis de vegetatione plantarum [75] inquirat, ei inspiciendum est ab ipsa satione seminis alicujus (id quod per extractionem, quasi singulis diebus, seminum quae per biduum, triduum, quatriduum, et sic deinceps, in terra manserunt, eorumque diligentem intuitum, facile fieri potest), quomodo et quando semen intumescere et turgere incipiat et veluti spiritu impleri; deinde quomodo corticulam rumpere et emittere fibras, cum latione nonnulla sui interim sursum, nisi terra fuerit admodum contumax; quomodo etiam emittat fibras, partim radicales deorsum, partim cauliculares sursum, aliquando serpendo per latera, si ex ea parte inveniat terram apertam et magis facilem; et complura id genus. Similiter facere oportet circa exclusionem ovorum; ubi facile conspici dabitur processus vivificandi et organizandi, et quid et quae partes fiant ex vitello, quid ex albumine ovi, et alia. Similis est ratio circa animalia ex putrefactione [76]. Nam circa

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As bearing on certain aspects of it, the student may read with advantage the Essay on Continuity, appended to Sir W. R. Grove's Correlation of Physical Forces, already referred to.

[74] Cp. the Aphorism on Latent Process, ii. 6: 'Cum enim omnis actio naturalis per minima transigatur, aut saltem per illa quae sunt minora quam ut sensum feriant, nemo se naturam regere aut vertere posse speret, nisi illa debito modo comprehenderit et notaverit.'

[75] For the interest which Bacon took in Gardens and Gardening, see the Essay 'Of Gardens' and the numerous 'experiments' in the Sylva Sylvarum, bearing on these subjects.

[76] 'The epithet perfecta is generally given to those animals which cannot result from putrefaction. Caesalpinus, in the Quaestiones Peripat. v. 1, maintains that all animals may result from putrefaction, and that this was the doctrine of Aristotle. The same opinion had, I believe, been advanced by Averrois. That mice may be produced by equivocal generation is asserted, as a matter not admitting of dispute, by Cardan, De Rerum

animalia perfecta et terrestria, per exectiones foetuum ex utero, minus humanum esset ista inquirere[77]; nisi forte per

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Varietate. Caesalpinus refers to the same instance, but less confidently than Cardan. It is worth remarking that Aristotle, though he speaks of the great fecundity of mice, and even of their being impregnated by licking salt, does not mention the possibility of their being produced by putrefaction. (De Hist. Animal. vi. 37, Problem. x. 64.) Paracelsus, De Rerum Generatione, affirms that all animals produced from putrefaction are more or less venomous. Telesius' opinion is that the more perfect animals cannot result from putrefaction, because the conditions of temperature necessary to their production cannot be fulfilled except by means of animal heat.' Mr. Ellis' note.

A brief summary of Aristotle's opinions as to the origin of animal life is given in the Historia Animalium, v. 1 (p. 539 a. 21–25): *οὕτω καὶ τῶν ζῴων τὰ μὲν ἀπὸ ζῴων γίνεται κατὰ συγγένειαν τῆς μορφῆς, τὰ δ' αὐτόματα καὶ οὐκ ἀπὸ συγγενῶν, καὶ τούτων τὰ μὲν ἐκ γῆς σηπομένης καὶ φυτῶν, ὥσπερ πολλὰ συμβαίνει τῶν ἐντόμων, τὰ δ' ἐν τοῖς ζῴοις αὐτοῖς ἐκ τῶν ἐν τοῖς μορίοις περιττωμάτων.* The subject of spontaneous generation frequently recurs both in the Historia Animalium and in the De Generatione Animalium (see especially i. 16 and iii. 11 of the latter treatise). Amongst the most interesting points of Aristotle's doctrine are the theory that spontaneous generation is due to the moisture which is found in putrefying matter (De Gen. An. iii. 11), and the statement that eels are the only animals, possessing blood, which do not arise either from congress or from eggs (Hist. An. vi. 16). Mr. Lewes has some good remarks on Aristotle's doctrine in his 'Aristotle,' pp. 364–6.

Bacon does not seem to have entertained any doubt as to the generation of animals from putrefaction. Cp. Sylva Sylvarum, Exps. 328, 900; Historia Densi et Rari (E. and S., vol. ii. p. 264). Sir Thomas Browne in his Enquiries into Vulgar and Common Errors (first published in 1646) appears to receive the doctrine with as little questioning. See, for instance, bk. ii. ch. 6: 'So when the ox corrupteth into bees, or the horse into hornets, they come not forth in the image of their originals. So the corrupt and excrementitious humours in men are animated into lice,' and more to the same effect. He even seems to believe in the equivocal generation of mice (bk. iii. ch. 28). These theories were all but finally disposed of by Harvey in his great Treatise, De Generatione Animalium, first published in 1651. There he maintains the thesis 'Ovum esse primordium commune omnibus animalibus.'

[77] And yet it is plain from the New Atlantis that Bacon did not object to vivisection. See the passage (E. and S., vol. iii. p. 159), beginning with the following remarkable sentences: 'We have also parks and inclosures of all sorts of beasts and birds, which we use not only for view or rareness, but likewise for dissections and trials; that thereby we may take light what may be wrought upon the body of man. Wherein we find many strange effects; as continuing life in them, though divers parts, which you account vital, be perished and taken forth; resuscitating of some that seem

occasiones abortuum, et venationum, et similium. Omnino igitur vigilia quaedam servanda est circa naturam, ut quae melius se conspiciendam praebeat noctu quam interdiu. Istae enim contemplationes tanquam nocturnae censeri possint, ob lucernae parvitatem et perpetuationem.

Quin et in inanimatis idem tentandum est; id quod nos fecimus in inquirendis aperturis liquorum per ignem[77]. Alius enim est modus aperturae in aqua, alius in vino, alius in aceto, alius in omphacio[78]; longe alius in lacte, et oleo, et caeteris[79]. Id quod facile cernere erat per ebullitionem super ignem lenem, et in vase vitreo, ubi omnia cerni perspicue possint. Verum haec brevius perstringimus; fusius et exactius de iis sermones habituri, cum ad inventionem *latentis* rerum *processus*[80] ventum erit. Semper enim memoria tenendum est, nos hoc loco non res ipsas tractare, sed exempla tantum adducere.

XLII.

Inter *praerogativas instantiarum* ponemus loco decimo nono *Instantias Supplementi*, sive *Substitutionis;* quas etiam *Instantias Perfugii* appellare consuevimus. Eae sunt, quae supplent informationem ubi sensus plane destituitur; atque idcirco ad eas confugimus cum instantiae propriae haberi non possint. Dupliciter autem fit substitutio; aut per Graduationem[81], aut per Analoga. Exempli gratia: non invenitur medium quod inhibeat prorsus operationem magnetis in movendo ferrum; non aurum interpositum, non argentum, non

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dead in appearance; and the like. We try also all poisons, and other medicines upon them, as well of chirurgery as physic.'

[77] See notes on last Aphorism and the passages in the Historia Densi et Rari, &c., there referred to. 'Apertura,' as Mr. Ellis remarks, means the same thing as 'Expansio.' It was a general term, used by the chemists of that period, to signify the modification which a substance undergoes, when it receives another, as it were, into its bosom.

[78] ὀμφάκιον, 'succus ex olea aut uva expressus, priusquam cibo aut vino maturae sint.' Facciolati. See Pliny, Nat. Hist. xii. 27 (60), sects. 130–31, xxiii. ad init., and other passages.

[79] See Historia Densi et Rari, E. and S., vol. ii. pp. 268–9.

[80] Cp. ii. 52 ad fin. This part of the Novum Organum was never written.

[81] As Mr. Kitchin remarks, one would have thought this was the office of the Tabula Graduum in Aph. 13.

lapis, non vitrum, lignum, aqua, oleum, pannus aut corpora fibrosa, aër, flamma, et caetera. Attamen per probationem exactam fortasse inveniri possit aliquod medium, quod hebetet virtutem ipsius plus quam aliquod aliud, comparative et in aliquo gradu: veluti quod non trahat magnes ferrum per tantam crassitiem auri quam per par spatium aëris; aut per tantum argentum ignitum quam per frigidum; et sic de similibus. Nam de his nos experimentum non fecimus; sed sufficit tamen ut proponantur loco exempli [82]. Similiter non invenitur hic apud nos corpus quod non suscipiat calidum igni approximatum. Attamen longe citius suscipit calorem aër [83] quam lapis. Atque talis est substitutio quae fit per Gradus.

Substitutio autem per Analoga, utilis sane, sed minus certa est; atque idcirco cum judicio quodam adhibenda. Ea fit, cum deducitur non-sensibile ad sensum, non per operationes sensibiles ipsius corporis insensibilis, sed per contemplationem corporis alicujus cognati sensibilis [84]. Exempli gratia: si inquiratur de Mistura Spirituum, qui sunt corpora non-visibilia,

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[82] I am informed that the question put by Bacon has not even yet been answered, the experiment being, on account of the various influences at work, of the most delicate description. It is possible, however, that the interposition of bismuth, and the so-called 'diamagnetic' substances generally, might, if we had sufficiently powerful instruments and sufficient means of measurement, be found to produce a perceptible influence in modifying the effect of a magnet on iron at a distance. Gold and silver are both included among the diamagnetic substances.

[83] The nature of Bacon's error with regard to air as a conductor of heat has already been pointed out. See notes on ii. 12 (18), (20); 13 (38). It will be noticed how loosely Bacon speaks of 'stone,' without distinguishing the different kinds of 'stones.'

[84] An excellent instance in modern science would be the analogy of vibrations or wave-motions as applied to the phenomena of Heat, Light, and Sound. Mr. Ellis says: 'Du Bois Raymond's Researches in Animal Electricity give a good example of this. He constructed what may be called an electrical model of a muscle, and succeeded in obtaining an illustration not only of his fundamental result, namely that any transverse section is negative with respect to any longitudinal one, but also of the more complicated relations between two different portions of the same section.'

The former of Bacon's illustrations, it is needless to say, is purely fanciful. The analogy, in the second case, corresponds pretty closely with facts.

videtur esse cognatio quaedam inter corpora et fomites sive alimenta sua. Fomes autem flammae videtur esse oleum et pinguia; aëris, aqua et aquea: flammae enim multiplicant se super halitus olei, aër super vapores aquae[85]. Videndum itaque de mistura aquae et olei, quae se manifestat ad sensum; quandoquidem mistura aëris et flammei generis fugiat sensum. At oleum et aqua inter se per compositionem aut agitationem imperfecte admodum miscentur: eadem in herbis, et sanguine, et partibus animalium, accurate et delicate miscentur. Itaque simile quiddam fieri possit circa misturam flammei et aërei generis in spiritalibus[86]: quae per confusionem simplicem non bene sustinent misturam, eadem tamen in spiritibus plantarum et animalium misceri videntur; praesertim cum omnis spiritus animatus depascat humida utraque, aquea et pinguia, tanquam fomites suos.

Similiter si non de perfectioribus misturis spiritalium, sed de compositione tantum inquiratur; nempe, utrum facile inter se incorporentur, an potius (exempli gratia) sint aliqui venti et exhalationes, aut alia corpora spiritalia, quae non miscentur cum aëre communi, sed tantum haerent et natant in eo, in globulis et guttis, et potius franguntur ac comminuuntur ab aëre quam in ipsum recipiuntur et incorporantur: hoc in aëre communi et aliis spiritalibus, ob subtilitatem corporum, percipi ad sensum non potest; attamen imago quaedam hujus rei, quatenus fiat, concipi possit in liquoribus argenti vivi, olei, aquae; atque etiam in aëre, et fractione ejus, quando dissipatur et ascendit in parvis portiunculis per aquam; atque etiam in fumis crassioribus; denique in pulvere excitato et haerente in aëre; in quibus omnibus non fit incorporatio. Atque repraesentatio praedicta in hoc subjecto non mala est, si illud primo diligenter inquisitum fuerit, utrum possit esse talis heterogenia inter spiritalia qualis invenitur inter liquida; nam tum demum haec simulacra per Analogiam non incommode substituentur.

Atque de *instantiis* istis *supplementi*, quod diximus infor-

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[85] See Aph. 48 (11), and the note upon the parallel passage in that place.

[86] The 'spiritus vitalis,' it will be recollected, was regarded by Bacon as composed of air and flame.

mationem ab iis hauriendam esse, quando desint instantiae propriae, loco *perfugii;* nihilominus intelligi volumus, quod illae etiam magni sint usus etiam cum propriae instantiae adsint; ad roborandam scilicet informationem una cum propriis. Verum de his exactius dicemus quando ad *Adminicula Inductionis* tractanda sermo ordine dilabetur.

XLIII.

Inter *praerogativas instantiarum* ponemus loco vicesimo *Instantias Persecantes;* quas etiam *Instantias Vellicantes* appellare consuevimus, sed diversa ratione. *Vellicantes* enim eas appellamus, quia vellicant intellectum, *persecantes*, quia persecant naturam[87]: unde etiam illas quandoque *Instantias Democriti*[88] nominamus. Eae sunt, quae de admirabili et exquisita subtilitate naturae intellectum submonent, ut excitetur et expergiscatur ad attentionem et observationem et inquisitionem debitam. Exempli gratia: quod parum guttulae atramenti ad tot literas vel lineas extendatur; quod argentum, exterius tantum inauratum, ad tantam longitudinem fili inaurati continuetur[89]; quod pusillus vermiculus[90], qualis in cute invenitur, habeat in se spiritum simul et figuram dissimilarem partium[91]; quod parum croci etiam dolium aquae colore inficiat; quod parum zibethi aut aromatis longe majus contentum aëris odore; quod exiguo suffitu tanta excitetur nubes fumi; quod sonorum tam accuratae differentiae, quales

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[87] 'The *instantiae persecantes*, or *vellicantes*,' says Professor Playfair, 'are those which force us to attend to things which, from their subtilty and minuteness, escape common observation.

'Some of Bacon's remarks on this subtilty are such as would do credit to the most advanced state of science, and shew how much his mind was fitted for distinguishing and observing the great and admirable in the works of nature.'

[88] Cp. i. 51.

[89] 'Dr. Woolaston's method for obtaining wires of extreme fineness was perhaps suggested by the circumstance mentioned in the text. He enclosed a gold wire in a cylinder of silver, drew them out together, and then dissolved away the silver by means of warm nitrous acid.' Mr. Ellis' note.

[90] See note 42 on ii. 34.

[91] 'The form of its parts dissimilar,' i. e. a varied organisation.

sint voces articulatae, per aërem undequaque vehantur, atque per foramina et poros etiam ligni et aquae (licet admodum extenuatae) penetrent, quin etiam repercutiantur, idque tam distincte et velociter; quod lux et color, etiam tanto ambitu et tam perniciter, per corpora solida vitri, aquae, et cum tanta et tam exquisita varietate imaginum permeent, etiam refringantur et reflectantur; quod magnes per corpora omnigena, etiam maxime compacta, operetur: sed (quod magis mirum est) quod in his omnibus, in medio adiaphoro (quale est aër) unius actio aliam non magnopere impediat; nempe quod eodem tempore per spatia aëris devehantur et visibilium tot imagines [92], et vocis articulatae tot percussiones, et tot odores specificati, ut violae, rosae; etiam calor et frigus et virtutes magneticae; omnia (inquam) simul, uno alterum non impediente, ac si singula haberent vias et meatus suos proprios separatos, neque unum in alterum impingeret aut incurreret.

Solemus tamen utiliter hujusmodi *instantiis persecantibus* subjungere instantias, quas *Metas Persecationis* appellare consuevimus; veluti quod in iis, quae diximus, una actio in diverso genere aliam non perturbet aut impediat, cum tamen in eodem genere [93] una aliam domet et extinguat: veluti, lux solis, lucem cicindelae; sonitus bombardae, vocem; fortior odor, delicatiorem; intensior calor, remissiorem; lamina ferri interposita inter magnetem et aliud ferrum, operationem magnetis [94].

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[92] This language bears traces of the old doctrine, according to which ἀπόρροιαι, emanations or images, were thrown off from outward objects and conveyed to the eyes. The student, who is interested in the history of this doctrine, will find it curious to compare the language employed by Bacon in the Sylva Sylvarum, Exps. 255–77 (E. and S., vol. ii. pp. 429–33), and to note there the intrusion of the newer optical theories on the old physical doctrine of emanations, as inherited from Empedocles and Democritus.

[93] This phenomenon is, of course, due to the fact that, when a sense is highly stimulated, stimuli of a low power have no effect upon it. See note 67 on Aph. 40.

[94] This example is only true with some qualification. A magnet developes magnetism in iron (this is called *magnetic induction*), and hence the piece of iron itself becomes a magnet, often supporting in turn another piece of iron, and so on, according to the power of the magnet, and the minuteness of the pieces. The way in which iron filings become attached to the poles of magnets is a familiar illustration of this principle. But, of

Verum de his quoque inter *Adminicula Inductionis* erit proprius dicendi locus.

XLIV.

Atque de instantiis quae juvant sensum, jam dictum est; quae praecipui usus sunt ad Partem Informativam. Informatio enim incipit a sensu. At universum negotium desinit in Opera; atque quemadmodum illud principium, ita hoc finis rei est [95]. Sequentur itaque instantiae praecipui usus ad *partem operativam*. Eae genere duae sunt, numero septem; quas universas, generali nomine, *Instantias Practicas* appellare consuevimus. *Operativae* autem *partis*, vitia duo; totidemque dignitates [96] instantiarum in genere. Aut enim fallit operatio, aut onerat nimis. Fallit operatio maxime (praesertim post diligentem naturarum inquisitionem) propter male determinatas et mensuratas corporum vires et actiones. Vires autem et actiones corporum circumscribuntur et mensurantur, aut per spatia loci, aut per momenta temporis, aut per unionem quanti, aut per praedominantiam virtutis [97]; quae quatuor nisi fuerint probe et diligenter pensitata, erunt fortasse scientiae speculatione quidem pulchrae, sed opere inactivae. Instantias vero quatuor itidem, quae huc referuntur, uno nomine *Instantias Mathematicas* vocamus, et *Instantias Mensurae*.

Onerosa autem fit praxis, vel propter misturam rerum inutilium, vel propter multiplicationem instrumentorum, vel propter molem materiae et corporum quae ad aliquod opus

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course, there are limits to magnetic induction, and the last piece of iron in the series, being itself so feebly magnetised as to be unable to support another, would furnish an example of what Bacon means. What, however, he more probably has in view is the still more common case, where the first piece of iron in contact with the magnet is unable to sustain any weight, either from being itself of some size, or from the feeble power of the magnet, or from a combination of both these circumstances.

[95] Cp. i. 73, 81, ii. 3 ad fin., and the numerous other passages in which this idea occurs.

[96] This word was used in the old Logic both for axioms (properly so called) and for propositions. See Hamilton on Reid, p. 766. But, in this place, there is no doubt that the word 'prerogatives,' adopted in Ellis and Spedding's Translation, is the true equivalent. Cp. end of this Aphorism.

[97] The meaning of this and the last phrase will be clear, when we come to Aphs. 47, 48.

requiri contigerint. Itaque eae instantiae in pretio esse debent, quae aut dirigunt operativam ad ea quae maxime hominum intersunt; aut quae parcunt instrumentis; aut quae parcunt materiae sive supellectili. Eas autem tres instantias quae huc pertinent, uno nomine *Instantias Propitias* sive *Benevolas* vocamus. Itaque de his septem instantiis jam sigillatim dicemus; atque cum iis partem illam de Praerogativis sive Dignitatibus Instantiarum claudemus.

XLV.

Inter *praerogativas instantiarum* ponemus loco vicesimo primo *Instantias Virgae*, sive *Radii* [98]; quas etiam *Instantias*

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[98] Examples of these 'instances' are not far to seek. We may notice the thermometer, the barometer, the hygrometer, the goniometer, the micrometer, the quadrant, scales, the photometer, the electrometer, the thermo-electric pile, &c. Besides instruments, we may also include methods of measurement, such as that of double-weighing or that of coincidences or interferences. The student will find many good examples both of instruments and methods amongst those given by Dr. Whewell in the Novum Organum Renovatum, bk. iii. ch. 2, or by Professor Jevons in the Principles of Science, bk. iii. Some interesting remarks on the subject of exact measurement, interspersed with illustrations, are made by Sir John Herschel, Discourse, &c., §§ 115–25, 226–30, 387–9.

These instances, it must be remembered, 'measure nature' 'per gradus spatii,' as the 'instantiae curriculi' 'per momenta temporis.' (See Aph. 46 ad init.)

In speaking of the defects of Bacon's method, Professor Playfair says: 'Another remark I must make on Bacon's method is, that it does not give sufficient importance to the *instantiae radii*, or those which furnish us with accurate measures of physical quantities. The experiments of this class are introduced as only subservient to practice; they are, however, of infinite value in the theoretical part of induction, or for ascertaining the causes and essences of the things inquired into. We have an instance of this in the discovery of that important truth in physical astronomy, that the moon is retained in her orbit by the force of gravity, or the same which, at the earth's surface, makes a stone fall to the ground. This proposition, however it might have been suspected to be true, could never have been demonstrated but by such observations and experiments as assigned accurate geometrical measures to the quantities compared. The semidiameter of the earth; the velocity of falling bodies at the earth's surface; the distance of the moon, and her velocity in her orbit;—all these four elements must have been determined with great precision, and afterwards compared together by certain theorems deduced from the laws of motion, before the relation between the force which retains the moon in

Perlationis, vel *de Non Ultra* appellare consuevimus. Virtutes enim rerum et motus operantur et expediuntur per spatia non indefinita aut fortuita, sed finita et certa; quae ut in singulis naturis inquisitis teneantur et notentur plurimum interest practicae, non solum ad hoc, ut non fallat, sed etiam ut magis sit aucta et potens. Etenim interdum datur virtutes producere, et distantias tanquam retrahere in propius; ut in perspecillis.

Atque plurimae virtutes operantur et afficiunt tantum per tactum manifestum; ut fit in percussione corporum, ubi alterum non summovet alterum, nisi impellens impulsum tangat. Etiam medicinae quae exterius applicantur, ut unguenta, emplastra, non exercent vires suas nisi per tactum corporis. Denique objecta sensuum tactus et gustus non feriunt nisi contigua organis.

Sunt et aliae virtutes quae operantur ad distantiam, verum valde exiguam, quarum paucae adhuc notatae sunt, cum tamen plures sint quam homines suspicentur: ut (capiendo exempla ex vulgatis) cum succinum aut gagates[99] trahunt paleas; bullae approximatae solvunt bullas[1]; medicinae nonnullae purgativae eliciunt humores ex alto[2], et hujusmodi. At virtus illa magnetica per quam ferrum et magnes, vel magnetes invicem[3], coëunt, operatur intra orbem virtutis certum, sed

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her orbit, and that which draws a stone to the ground, could possibly be discovered. The discovery also, when made, carried with it the evidence of demonstration; so that here, as in many other cases, the *instantiae radii* are of the utmost importance in the theoretical part of Physics.'

Again, after speaking, in a passage which is well worth the attention of the student, of the generalisations accomplished by the methods of geometry, he adds: 'This can only happen when the experiments afford accurate measures of the quantities concerned, like the *instantiae radii, curriculi*, &c.; and this advantage of admitting generalisation with so much certainty is one of their properties, of which it does not appear that even Bacon himself was aware.'

99 'Amber or jet.'

1 See note 65 on Aph. 25.

2 'Bacon here speaks in accordance with the medical theory in which the brain is the origin and seat of the rheum, which descends from thence and produces disease in other organs—a theory preserved in the word catarrh. Certain purgatives were supposed to draw the rheum down.' Mr. Ellis' note.

3 On the mutual attraction of magnets for one another, see Gilbert, De Magnete, lib. i. cap. 5.

parvum; ubi contra, si sit aliqua virtus magnetica emanans ab ipsa terra (paulo nimirum interiore[4]) super acum ferream, quatenus ad verticitatem, operatio fiat ad distantiam magnam.

Rursus, si sit aliqua vis magnetica quae operetur per consensum inter globum terrae et ponderosa[5], aut inter globum lunae et aquas maris[6] (quae maxime credibilis videtur in fluxibus et refluxibus semi-menstruis), aut inter coelum stellatum et planetas, per quam evocentur et attollantur ad sua apogaea[7]; haec omnia operantur ad distantias admodum longinquas. Inveniuntur et quaedam inflammationes sive conceptiones flammae, quae fiunt ad distantias bene magnas, in aliquibus materiis; ut referunt de naphtha Babylonica[8].

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[4] 'A little below the surface.' Cp. Gilbert, De Magnete, lib. i. cap. 17: 'Talis igitur nobis est tellus in interioribus partibus, magneticam homogenicam naturam habens,' &c.

The earth may be compared with an immense magnet, whose poles, though variable, approach more or less nearly to the terrestrial poles, and whose neutral line cuts the equator at very acute angles.

[5] Cp. ii. 36 (3) and 37, with notes.

[6] See ii. 35 and 36 (1), with notes. In both these places, he is speaking of the ebb and flow which takes place twice a day. Here, he speaks of the spring and neap tides, each of which occurs twice a month, namely at new and full moon and at the first and last quarters, respectively.

It is curious to note Bacon's change of opinion with regard to the cause of these semi-menstrual phenomena; for in the De Fluxu et Refluxu Maris, written before or not long after 1616, he rejects the hypothesis of the influence of the moon, using, as his main argument, the fact that, when the moon is in opposite conditions, namely new and full moon, the same tidal phenomena take place. 'Et multa alia,' he adds, 'adduci possint quae hujusmodi dominationum phantasias destruant, et eo potius rem deducant, ut ex materiae passionibus catholicis et primis rerum coagmentationibus consensus illi oriantur, non quasi alterum ab altero regatur, sed quod utrumque ab iisdem originibus et concausis emanet.' E. and S., vol. iii. p. 52.

On the semi-diurnal ebb and flow, it will be remembered, Bacon was probably inclined to adopt an entirely different theory. See note 54 on Aph. 35.

[7] Note this curious suggestion, that the motions of the planets are due to the magnetic attraction of the coelum stellatum. Cp. Thema Coeli (E. and S., vol. iii. p. 779): 'Affirmant motum magneticum sive congregativum vigere in astris, ex quo ignis ignem evocat et attollit.' I am not aware whether this idea is to be found in any other writer.

[8] See Herodotus, i. 179; Strabo, xvi. 1 (Ed. Casaubon, p. 743); Pliny,

Calores etiam insinuant se per distantias amplas, quod etiam faciunt frigora; adeo ut habitantibus circa Canadam moles sive massae glaciales, quae abrumpuntur et natant per oceanum septentrionalem et deferuntur per Atlanticum versus illas oras, percipiantur et incutiant frigora e longinquo. Odores quoque (licet in his videatur semper esse quaedam emissio corporea [9]) operantur ad distantias notabiles; ut evenire solet navigantibus juxta litora Floridae, aut etiam nonnulla Hispaniae, ubi sunt sylvae totae ex arboribus limonum, arantiorum [10], et hujusmodi plantarum odoratarum, aut frutices rorismarini, majoranae, et similium [11]. Postremo radiationes lucis et impressiones sonorum operantur scilicet ad distantias spatiosas.

Verum haec omnia, utcunque operentur ad distantias parvas sive magnas, operantur certe ad finitas et naturae notas, ut sit quiddam *Non Ultra:* idque pro rationibus, aut molis seu quanti corporum; aut vigoris et debilitatis virtutum; aut favoribus et impedimentis mediorum; quae omnia in computationem venire et notari debent. Quinetiam mensurae motuum violentorum (quos vocant), ut missilium, tormentorum, rotarum, et similium, cum hae quoque manifesto suos habeant limites certos, notandae sunt.

Inveniuntur etiam quidam motus et virtutes contrariae illis, quae operantur per tactum et non ad distans; quae operantur scilicet ad distans et non ad tactum; et rursus, quae operantur remissius ad distantiam minorem et fortius ad distantiam

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ii. 105 (109), sect. 235, xxiv. 17 (101), sect. 158; Plutarch's Life of Alexander, ch. 35.

[9] This supposition is, of course, right. Cp. Cogitationes De Natura Rerum, E. and S., vol. iii. pp. 15, 16; Sylva Sylvarum, Exp. 834. In the latter passage, he says: 'It is true that some woods of oranges, and heaths of rosemary, will smell a great way into the sea, perhaps twenty miles.'

[10] This is probably a misprint for aurantiorum, oranges.

[11] Mr. Ellis refers to Paradise Lost, iv. 99 (it should be 159, &c.):

'As when to those who sail
Beyond the Cape of Hope, and now are past
Mozambic, off at sea North-East winds blow
Sabean Odours from the spicy shore
Of Arabie the blest, with such delay
Well pleas'd they slack their course, and many a League
Cheer'd with the grateful smell old Ocean smiles.'

majorem. Etenim visio non bene transigitur ad tactum, sed indiget medio et distantia[12]. Licet meminerim me audisse ex relatione cujusdam fide digni, quod ipse in curandis oculorum suorum cataractis (erat autem cura talis, ut immitteretur festuca[13] quaedam parva argentea intra primam oculi tunicam, quae pelliculam illam cataractae removeret et truderet in angulum oculi) clarissime vidisset festucam illam supra ipsam pupillam moventem. Quod utcunque verum esse possit, manifestum est majora corpora non bene aut distincte cerni nisi in cuspide coni, coëuntibus radiis objecti ad nonnullam distantiam[14]. Quin etiam in senibus oculus melius cernit remoto objecto paulo longius, quam propius[15]. In missilibus autem certum est percussionem non fieri tam fortem ad distantiam nimis parvam, quam paulo post[16]. Haec itaque et similia in mensuris motuum quoad distantias notanda sunt.

Est et aliud genus mensurae localis motuum, quod non praetermittendum est. Illud vero pertinet ad motus non

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[12] Cp. Sylva Sylvarum, Exp. 272, where the same story about the operation for cataract is told. There is, I am informed, no intrinsic improbability in it.

On the power of accommodation by which the eye adapts itself to variations in the distances of objects, the student, who is not already acquainted with the structure of the eye and the phenomena of the sense of vision, may consult Ganot's Physics, 7th Ed., §§ 582–3, or Carpenter's Physiology, 4th Ed., § 877. It generally requires a great effort to see very near objects, and at a certain distance from the eye, varying with different persons and with the size and colour of the objects, the image on the retina becomes blurred.

[13] A needle.

[14] Sc. from the object itself, not from the retina of the eye, which would be absurd.

[15] This is true, as a general rule. 'We commonly meet with myopia (short-sightedness) in young persons, and with presbyopia (long-sightedness) in old: but this is by no means the invariable rule; for even aged persons are sometimes "short-sighted," and "long-sightedness" is occasionally met with amongst the young.' Dr. Carpenter, Physiology, § 879.

[16] While the ball is travelling upwards, the velocity diminishes instead of increasing, and so, contrary to what Bacon supposed, the initial velocity is greater than the velocity at any other point on the upward path. A projectile traces a parabola, and it may easily be shown that the velocity at any point of the parabola is that which would be acquired in falling from the directrix.

progressivos, sed sphaericos; hoc est, ad expansionem corporum in majorem sphaeram, aut contractionem in minorem. Inquirendum enim est inter mensuras istas motuum, quantam compressionem aut extensionem corpora (pro natura ipsorum) facile et libenter patiantur, et ad quem terminum reluctari incipiant, adeo ut ad extremum *Non Ultra* ferant; ut cum vesica inflata comprimitur, sustinet illa compressionem nonnullam aëris, sed si major fuerit, non patitur aër, sed rumpitur vesica.

At nos hoc ipsum subtiliore experimento magis exacte probavimus. Accepimus enim campanulam ex metallo, leviorem scilicet et tenuiorem, quali ad excipiendum salem utimur; eamque in pelvim aquae immisimus, ita ut deportaret secum aërem qui continebatur in concavo usque ad fundum pelvis. Locaveramus autem prius globulum in fundo pelvis, super quem campanula imponenda esset. Quare illud eveniebat, ut si globulus ille esset minusculus (pro ratione concavi), reciperet se aër in locum minorem, et contruderetur solum, non extruderetur. Quod si grandioris esset magnitudinis quam ut aër libenter cederet, tum aër majoris pressurae impatiens campanulam ex aliqua parte elevabat, et in bullis ascendebat.

Etiam ad probandum qualem extensionem[17] (non minus quam compressionem) pateretur aër, tale quippiam practicavimus. Ovum vitreum accepimus, cum parvo foramine in uno extremo ovi. Aërem per foramen exuctione forti attraximus, et statim digito foramen illud obturavimus, et ovum in aquam immersimus, et dein digitum removimus. Aër vero tensura illa per exuctionem facta tortus et magis quam pro natura sua dilatatus, ideoque se recipere et contrahere nitens (ita ut si ovum illud in aquam non fuisset immersum, aërem ipsum traxisset cum sibilo), aquam traxit ad tale quantum quale sufficere

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[17] Thus, Bacon recognised the Elasticity of Air, but, as Dr. Whewell remarks (History of the Inductive Sciences, bk. x. ch. 3. sect. 1), the broad facts which exhibit this phenomenon are tolerably evident. It is the reduction of them to law and measurement which has constituted the merit of the researches of Boyle and others. At the same time, Bacon ought to have the credit of the curiosity which he felt on this subject, and of the idea of instituting experiments on it.

posset ad hoc, ut aër antiquam recuperaret sphaeram sive dimensionem[18].

Atque certum est corpora tenuiora (quale est aër) pati contractionem nonnullam notabilem, ut dictum est; at corpora tangibilia (quale est aqua) multo aegrius et ad minus spatium patiuntur compressionem. Qualem autem patiatur, tali experimento inquisivimus.

Fieri fecimus globum ex plumbo cavum, qui duas circiter pintas vinarias contineret; eumque satis per latera crassum, ut majorem vim sustineret. In illum aquam immisimus, per foramen alicubi factum; atque foramen illud, postquam globus aqua impletus fuisset, plumbo liquefacto obturavimus, ut globus deveniret plane consolidatus. Dein globum forti malleo ad duo latera adversa complanavimus; ex quo necesse fuit aquam in minus contrahi, cum sphaera figurarum sit capacissima. Deinde, cum malleatio non amplius sufficeret, aegrius se recipiente aqua, molendino[19] seu torculari usi sumus; ut tandem aqua, impatiens pressurae ulterioris, per solida plumbi (instar roris delicati) exstillaret. Postea, quantum spatii per eam compressionem imminutum foret computavimus; atque tantam compressionem passam esse aquam (sed violentia magna subactam) intelleximus[20].

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[18] 'This explanation is wholly unsatisfactory. The principle upon which the true explanation depends, namely the pressure of the atmosphere, was, it seems tolerably certain, first suggested by Torricelli. If the experiment were performed in vacuo, no water would enter the egg, unless the egg were plunged to a considerable depth into the water, or unless the vacuum within it were more perfect than could be produced in the manner described.' Mr. Ellis' note.

The two preceding experiments, though rough, when compared with more recent proofs, must be admitted as affording evidence of the compressibility and elasticity of air.

[19] A Low Latin word for a mill. See Du Cange, and cp. Historia Ventorum, E. and S., vol. ii. pp. 64–5. It is here, as Mr. Ellis observes, used for a press.

[20] Cp. Aph. 50, Modus Secundus, and Historia Densi et Rari, E. and S., vol. ii. pp. 299–300. From a comparison of these passages with that in the text, it is plain that Bacon imagined the experiment to be successful, and that he had thereby proved the compressibility of water. The fact that the water exuded through the pores of the lead ought, however, to have shown him that the experiment was one which could not be relied upon.

At solidiora, sicca, aut magis compacta, qualia sunt lapides et ligna, necnon metalla, multo adhuc minorem compressionem aut extensionem, et fere imperceptibilem ferunt[21]; sed vel fractione, vel progressione, vel aliis pertentationibus se liberant:

'This,' says Mr. Ellis, 'is perhaps the most remarkable of Bacon's experiments; and it is singular that it was so little spoken of by subsequent writers. Nearly fifty years after the publication of the Novum Organum, an account of a similar experiment was published by Megalotti, who was secretary of the Accademia del Cimento at Florence; and it has since been familiarly known as the Florentine experiment. I quote his account of it. 'Facemmo lavorar di getto una grande ma sottil palla d'argento, e quella ripiena d'acqua raffreddata col ghiaccio serramo con saldissime vite. Di poi cominciammo a martellaria leggiermente per ogni verso, onde ammaccato l'argento (il quale per la sua crudezza non comporta d'assottigliarsi e distendersi come farebbe l'oro raffinato, o il piombo, o altro metallo più dolce) veniva a ristrignersi, e scemare la sua interna capacità, senza che l'acqua patisse una minima compressione, poichè ad ogni colpo si videa trasudare per tutti i pori del metallo a guisa d'argento vivo il quale da alcuna pelle premuto minutamente sprizzasse.'—Saggi di naturali Esperienze fatte nell' Accademia del Cimento, p. 204, Firenze, 1667. The writer goes on to remark that the absolute incompressibility of water is not proved by this experiment, but merely that it is not to be compressed in the manner described. But the experiment is on other grounds inconclusive.

'It is to be remarked that Leibnitz, Nouveaux Essais, in mentioning the Florentine experiment, says that the globe was of gold (p. 229, Erdmann), whereas the Florentine academicians expressly say why they preferred silver to either gold or lead.'

Notwithstanding the unsatisfactory character of these experiments, the compressibility of liquids has been fully demonstrated by Canton, Oersted, and others. For an account of the *piezometer*, the instrument which is used for measuring the amount of compressibility of various liquids, see Ganot's Physics, 7th Ed., § 94. Ether is much more compressible than water, and fresh water distinctly more so than sea water. In general, the densest liquids are those least capable of compression.

[21] Compressibility seems to be an universal property of matter, being at once a consequence and a proof of porosity. The compressibilty of solids, though much less than that of gases, is greater, often much greater, than that of liquids. 'It is found in all degrees. Cloths, paper, cork, woods are amongst the most compressible of solid substances. Metals are so also to a great extent, as is proved by the process of coining, in which the metal receives the impression from the die. There is, in most cases, a limit beyond which, when the pressure is increased, bodies are fractured or reduced to powder.' Ganot's Physics, § 16.

ut in curvationibus ligni aut metalli, horologiis moventibus per complicationem laminae, missilibus, malleationibus, et innumeris aliis motibus apparet. Atque haec omnia cum mensuris suis in indagatione naturae notanda et exploranda sunt, aut in certitudine sua, aut per aestimativas, aut per comparativas, prout dabitur copia.

XLVI.

Inter *praerogativas instantiarum* ponemus loco vicesimo secundo *Instantias Curriculi*[22], quas etiam *Instantias ad Aquam* appellare consuevimus; sumpto vocabulo a clepsydris apud antiquos, in quas infundebatur aqua, loco arenae. Eae mensurant naturam per momenta temporis, quemadmodum *Instantiae Virgae* per gradus spatii. Omnis enim motus sive actio naturalis transigitur in tempore; alius velocius, alius tardius, sed utcunque momentis certis et naturae notis. Etiam illae actiones quae subito videntur operari, et in ictu oculi (ut loquimur), deprehenduntur recipere majus et minus quoad tempus[23].

Primo itaque videmus restitutiones corporum coelestium fieri per tempora numerata; etiam fluxus et refluxus maris. Latio autem gravium versus terram et levium versus ambitum coeli fit per certa momenta, pro ratione corporis quod fertur, et medii[24]. At velificationes navium, motus animalium,

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[22] Amongst the instruments which furnish examples of this 'Instance,' we may adduce the dial, the pendulum, the clock, the watch, the chronometer, the electric clock, the transit instrument, &c., and, amongst methods, the various divisions of time, the personal equation as employed in astronomical observatories, the modes of calculating the velocity of sound, light, electricity, &c. Mr. Kitchin remarks very well that the various applications of the Infinitesimal Calculus afford a good illustration both of this and of the last Aphorism.

The works referred to in the first note to the last Aphorism, will also serve for the illustration of this.

[23] 'Glaring instances' of this statement would be light and conducted electricity.

[24] Φέρεται δέ γε θᾶττον τὸ πλεῖον ἄνω πῦρ τοῦ ἐλάττονος, καὶ κάτω δὲ πάλιν ὡσαύτως ὁ πλείων χρυσὸς καὶ ὁ μόλιβδος· ὁμοίως δὲ καὶ τῶν ἄλλων ἕκαστον τῶν ἐχόντων βάρος. Arist. De Coelo, iv. 2 (p. 309 b. 12–15).

Compare, in addition to the passage towards the end of the next Aphorism, De Augmentis, v. 2 (E. and S., vol. i. p. 625): 'Variatio Experimenti fit tertio in Quanto; circa quod diligens admodum est adhibenda cura, cum hoc multi circumstent errores. Credunt enim homines, aucta aut multipli-

perlationes missilium, omnes fiunt itidem per tempora (quantum ad summas) numerabilia. Calorem vero quod attinet, videmus pueros per hyemem manus in flamma lavare, nec tamen uri; et joculatores vasa plena vino vel aqua, per motus agiles et aequales, vertere deorsum et sursum recuperare, non effuso liquore; et multa hujusmodi. Nec minus ipsae compressiones et dilatationes et eruptiones corporum fiunt, aliae velocius, aliae tardius, pro natura corporis et motus, sed per momenta certa. Quinetiam in explosione plurium bombardarum simul, quae exaudiuntur quandoque ad distantiam triginta milliarium, percipitur sonus prius ab iis qui prope absunt a loco ubi fit sonitus, quam ab iis qui longe[25]. At

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cata quantitate, pro rata augeri aut multiplicari virtutem. Et hoc fere postulant et supponunt, tanquam res sit mathematicae cujusdam certitudinis; quod omnino falsissimum est. *Globus plumbeus unius librae* a turri demissus (puta) decem pulsuum spatio ad terram descendit: num globus duarum librarum (in quo impetus iste motus, quem vocant, naturalis duplicari debet) spatio quinque pulsuum terram feriet? At ille aequali fere tempore descendet, neque accelerabitur juxta rationem Quanti.' These passages, though Bacon makes no reference to Galileo, shew plainly enough that he had given up the old Peripatetic and Scholastic doctrine (for which see my Inductive Logic, 3rd Ed., p. 256), that heavy bodies fall to the earth in times inversely proportional to their weights, or, in other words, that their velocities are directly proportional to their weights. This doctrine, though for a long time obstinately adhered to by his opponents, had been exploded by Galileo by means of the experiments which he made from the leaning tower of Pisa about 1590. He maintained (and rightly) that all bodies, whatever their weight, would, if we could remove the resistance of the air, fall through equal vertical spaces in equal times. See Dialogo dei Massimi Sistemi, Giornata Seconda, Florentine Ed. of 1842, vol. i. pp. 245–46; also Sermones de Motu Gravium, vol. xi. pp. 48–9. The doctrine, which Galileo combated, pleaded for itself the authority of Aristotle. See the passage above quoted, and, with reference to the proportion, De Coelo, iii. 2 (p. 301 b. 1–17).

It is almost superfluous to add that Bacon is right in making the 'ratio medii' an element in the enquiry. The differences in the velocities of bodies falling through the same vertical spaces are, in fact, entirely determined by the various media through which the bodies fall and the different relations subsisting between the two.

[25] Cp. the very interesting passages on the motion and velocity of Sound in Sylva Sylvarum, Exps. 207–11, where Bacon proposes an experiment for the purpose of determining the rate at which sound moves. In principle, the experiment, which consists in comparing the time of seeing a light with that of hearing a sound, is the same as that from which the velocity of

in visu (cujus actio est pernicissima) liquet etiam requiri ad eum actuandum momenta certa temporis: idque probatur ex iis quae propter motus velocitatem non cernuntur; ut ex latione pilae ex sclopeto [26]. Velocior enim est praetervolatio pilae quam impressio speciei ejus quae deferri poterat ad visum.

Atque hoc, cum similibus, nobis quandoque dubitationem peperit plane monstrosam [27]: videlicet, utrum coeli sereni et stellati facies ad idem tempus cernatur quando vere existit, an potius aliquanto post; et utrum non sit (quatenus ad visum coelestium) non minus tempus verum et tempus visum, quam locus verus et locus visus, qui notatur ab astronomis in parallaxibus [28]. Adeo incredibile nobis videbatur, species sive radios corporum coelestium per tam immensa spatia milliarium subito deferri posse ad visum; sed potius debere eas in tempore aliquo notabili delabi. Verum illa dubitatio (quoad majus aliquod intervallum temporis inter tempus

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sound has been actually ascertained. This in dry air and at 0° C. is about 1093 ft. in a second.

There are many stories of the distances at which sounds have been heard. The firing at Waterloo is said to have been heard at Dover, and sometimes the reports of cannon or volcanoes are said to have been carried distances of 200, or even 300 miles.

[26] This incapacity is due partly to the colour of the ball (for we do see a rocket), partly to the fact that the eye cannot adjust itself with sufficient rapidity to its constantly changing positions.

Note again, in the language of the next sentence, the traces of the old theory of 'sensible species.' Cp. Aph. 43 and note 92.

[27] It is almost needless to say that this 'dubitatio plane monstrosa' has been amply justified. 'The measurement of the Velocity of light,' says Professor Playfair, 'and the wonderful consequences arising from it, are the best commentaries on this passage, and the highest eulogy on its Author.'

Taking the velocity of light at 190,000 miles a second, it requires 8^{m} 18^{s} to traverse a semi-diameter of the earth's orbit. From this it is calculated that the light which the very nearest fixed stars send us must take *at least* 3¼ years to reach us, while the light of some of the stars in the galaxy must have occupied more than 2000 years in travelling over the distance which separates them from our own system. See, for more detailed information, Herschel's Astronomy, 10th Ed., §§ 801–3.

[28] On parallax and the corrections for it, see Herschel's Astronomy, §§ 338–42.

verum et visum) postea plane evanuit [29]: reputantibus nobis jacturam illam infinitam et diminutionem quanti, quatenus ad apparentiam, inter corpus stellae verum et speciem visam, quae causatur a distantia; atque simul notantibus ad quantam distantiam (sexaginta scilicet ad minimum milliariorum) corpora, eaque tantum albicantia, subito hic apud nos cernantur; cum dubium non sit lucem coelestium, non tantum albedinis vividum colorem, verum etiam omnis flammae (quae apud nos nota est) lucem, quoad vigorem radiationis, multis partibus excedere. Etiam immensa illa velocitas in ipso corpore, quae cernitur in motu diurno (quae etiam viros graves ita obstupefecit ut mallent credere motum terrae [30]), facit motum illum ejaculationis radiorum ab ipsis (licet celeritate, ut diximus, mirabilem) magis credibilem. Maxime vero omnium nos movit, quod si interponeretur intervallum temporis aliquod notabile inter veritatem et visum, foret ut species per nubes interim orientes et similes medii perturbationes interciperentur saepenumero, et confunderentur [31]. Atque de mensuris temporum simplicibus haec dicta sint.

Verum non solum quaerenda est mensura motuum et actionum simpliciter, sed multo magis comparative: id enim eximii est usus, et ad plurima spectat. Atque videmus flammam alicujus tormenti ignei citius cerni, quam sonitus audiatur; licet necesse sit pilam prius aërem percutere, quam flamma quae

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[29] We hardly know which to admire most, the felicity of Bacon's conjecture or the perverted ingenuity of the arguments by which he attempts to explain it away. The first argument shews what a strangely inadequate notion he had of the distance of the fixed stars from us.

[30] This passage, even if it stood alone, would shew pretty plainly that Bacon did not believe in the diurnal motion of the earth. Cp. Aph. 36 (2), and note 86; also Introduction, pp. 34–5.

[31] I think that Bacon must here have in mind cosmical clouds, in the interstellar spaces, not ordinary or aerial clouds. The argument is that the light of the stars, if it took a long time for its transmission, would be frequently stopped by various obstacles in the sky, whereas, on a clear night, we invariably see the stars where we expect to find them. At the same time, it must be confessed that, if there were such obstacles as I am supposing Bacon to contemplate, the light might sometimes be intercepted, however instantaneous its transmission. There is, then, an undoubted difficulty in the passage, though it does not appear to me so great as it seems to appear to Mr. Spedding.

pone erat exire potuerit; fieri hoc autem propter velociorem transactionem motus lucis, quam soni. Videmus etiam species visibiles a visu citius excipi quam dimitti[32]; unde fit quod nervi fidium, digito impulsi, duplicentur aut triplicentur quoad speciem, quia species nova recipitur, antequam prior demittatur[33]; ex quo etiam fit, ut annuli rotati videantur globosi, et fax ardens, noctu velociter portata, conspiciatur caudata. Etiam ex hoc fundamento inaequalitatis motuum quoad velocitatem, excogitavit Galilaeus[34] causam fluxus et refluxus maris; rotante terra velocius, aquis tardius; ideoque accumulantibus se aquis in sursum, et deinde per vices se remittentibus in deorsum, ut demonstratur in vase aquae incitatius movente. Sed hoc commentus est concesso non concessibili[35] (quod

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[32] The retention of images on the retina of the eye is a familiar phenomenon, of which the reader will easily supply himself with instances. The duration of the persistence varies with the intensity of the light and the sensitiveness of the organ. 'M. Plateau has investigated the duration of the impression by numerous methods, and has found that it is on the average half a second. * * * A great number of pieces of apparatus are founded on the persistence of sensation on the retina. Such are the thaumatrope, the phenakistoscope, Faraday's wheel, the kaleidophone.' Ganot's Physics, § 588 (8th Ed., § 607).

[33] Mr. Ellis says that 'in the case of vibrating strings Bacon's explanation is not altogether complete. The distinct or quasi-distinct images to which he refers correspond to limiting positions of the vibrating string.'

[34] 'This account of Galileo's theory of the tides is inaccurate. In this theory the tides are caused by the varying velocity of different points of the earth's surface, arising from the composition of the earth's two motions, namely that about its axis, and that in its orbit. Bacon does not seem to have perceived that both these motions are essential to the explanation. That the earth's being in motion might be the cause of the tides, had been suggested before the time of Galileo by Caesalpinus in the Quaestiones Peripateticae, iii. 5. It is odd that Patritius, in giving an account of all the theories which had in his time been devised to explain the cause of the tides (see his Pancosmia, l. 28), does not mention Caesalpinus', though it was published some years before his own work. Galileo perhaps alludes to Caesalpinus in his letter to Cardinal Orsino, dated 8th January, 1616. See, for remarks on Caesalpinus' doctrine, the Problemata Marina of Casmann, published in 1596. Casmann's own theory is that of expansion.' Mr. Ellis' note. See also my notes on Aph. 36 (1). Galileo's Theory of the Tides will be found stated at length in his Dialogo dei Massimi Sistemi, Giornata Quarta.

[35] See note 30 above on this subject. In the present passage, Bacon

terra nempe moveatur), ac etiam non bene informatus[36] de oceani motu sexhorario.

At exemplum hujus rei de qua agitur, videlicet, de comparativis mensuris motuum, neque solum rei ipsius, sed et usus insignis ejus (de quo paulo ante loquuti sumus), eminet in cuniculis subterraneis, in quibus collocatur pulvis pyrius; ubi immensae moles terrae, aedificiorum, et similium, subvertuntur, et in altum jaciuntur, a pusilla quantitate pulveris pyrii[37]. Cujus causa pro certo illa est, quod motus dilatationis pulveris, qui impellit, multis partibus sit pernicior, quam motus gravitatis per quem fieri possit aliqua resistentia; adeo ut primus motus perfunctus sit, antequam motus adversus inceperit; ut in principiis nullitas quaedam sit resistentiae. Hinc etiam fit, quod in omni missili, ictus, non tam robustus quam acutus et celer, ad perlationem potissimum valeat. Neque etiam fieri potuisset, ut parva quantitas spiritus animalis[38] in animalibus, praesertim in tam vastis corporibus qualia sunt balaenae aut elephanti, tantam molem corpoream flecteret et regeret, nisi propter velocitatem motus spiritus, et hebetudinem corporeae molis, quatenus ad expediendam suam resistentiam.

Denique, hoc unum ex praecipuis fundamentis est experimentorum magicorum, de quibus mox dicemus[39]; ubi scilicet parva moles materiae longe majorem superat et in ordinem redigit: hoc, inquam, si fieri possit anteversio motuum per velocitatem unius, antequam alter se expediat.

Postremo, hoc ipsum *Prius* et *Posterius* in omni actione naturali notari debet; veluti quod in infusione rhabarbari[40] eliciatur purgativa vis prius, astrictiva post; simile quiddam

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may mean nothing more than that Galileo assumed what required to be proved.

[36] See the passage on the Tides in Aph. 36 (1).

[37] In describing Blasting, as Mr. Kitchin observes, Bacon confuses the resistance of inertia with the force of gravity. There is in these cases no 'anticipation of motion,' 'anteversio motus,' as Bacon calls it here and in Aph. 51.

[38] On Bacon's curious conception of 'Spirit,' cp. Aph. 40 and the other passages referred to in the notes on that Aphorism.

[39] See Aph. 51.

[40] Rhubarb. Cp. Sylva Sylvarum, Exp. 19.

etiam in infusione violarum[41] in acetum experti sumus; ubi primo excipitur suavis et delicatus floris odor; post, pars floris magis terrea, quae odorem confundit. Itaque si infundantur violae per diem integrum, odor multo languidius excipitur: quod si infundantur per partem quartam horae tantum, et extrahantur; et (quia paucus est spiritus odoratus qui subsistit in viola) infundantur post singulas quartas horae violae novae et recentes ad sexies; tum demum nobilitatur infusio, ita ut licet non manserint violae, utcunque renovatae, plus quam ad sesquihoram, tamen permanserit odor gratissimus, et viola ipsa non inferior, ad annum integrum. Notandum tamen est, quod non se colligat odor ad vires suas plenas, nisi post mensem ab infusione. In distillationibus vero aromatum maceratorum in spiritu vini patet quod surgat primo phlegma aqueum et inutile, deinde aqua plus habens ex spiritu vini, deinde post aqua plus habens ex aromate. Atque hujus generis quamplurima inveniuntur in distillationibus notatu digna. Verum haec sufficiant ad exempla.

XLVII.

Inter *praerogativas instantiarum* ponemus loco vicesimo tertio *Instantias Quanti*, quas etiam *Doses Naturae* (sumpto vocabulo a Medicinis) vocare consuevimus[42]. Eae sunt quae mensurant virtutes per *Quanta* corporum, et indicant quid *Quantum Corporis* faciat ad *Modum Virtutis*. Ac primo sunt quaedam virtutes quae non subsistunt nisi in *quanto cosmico*, hoc est, tali *quanto* quod habeat consensum cum configuratione et fabrica universi. Terra enim stat; partes ejus cadunt. Aquae in maribus fluunt et refluunt; in fluviis minime,

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[41] Cp. Sylva Sylvarum, Exp. 17.

[42] These 'instantiae' are peculiarly valuable in medicine. The whole Pharmacopoeia, in fact, is an illustration of them. See some very interesting remarks on the Doses of Medicinal Substances and the circumstances by which their effects are modified in Dr. Paris' Pharmacologia, 9th Ed., pp. 453–67, and cp. pp. 120–3.

The law of definite proportions in chemistry might be brought under this head of instances, without doing much violence to them, though, of course, Bacon had himself no conception of it.

In connection with this Aphorism, the student may again consult Herschel's Discourse, &c., §§ 115–6.

nisi per ingressum maris. Deinde etiam omnes fere virtutes particulares secundum multum aut parvum corporis operantur. Aquae largae non facile corrumpuntur; exiguae cito. Mustum et cervisia maturescunt longe citius, et fiunt potabilia, in utribus parvis, quam in doliis magnis. Si herba ponatur in majore portione liquoris, fit infusio, magis quam imbibitio[43]; si in minore, fit imbibitio, magis quam infusio. Aliud igitur erga corpus humanum est balneum, aliud levis irroratio. Etiam parvi rores in aëre nunquam cadunt[44], sed dissipantur et cum aëre incorporantur. Et videre est in anhelitu super gemmas, parum illud humoris, quasi nubeculam vento dissipatam, continuo solvi. Etiam frustum ejusdem magnetis non trahit tantum ferri, quantum magnes integer. Sunt etiam virtutes in quibus parvitas *quanti* magis potest; ut in penetrationibus, stylus acutus citius penetrat, quam obtusus; adamas punctuatus sculpit in vitro; et similia.

Verum non hic morandum est in indefinitis, sed etiam de *rationibus quanti* corporis erga modum virtutis inquirendum. Proclive enim foret credere, quod rationes quanti rationes virtutis adaequarent; ut si pila plumbea unius unciae caderet in tali tempore, pila unciarum duarum deberet cadere duplo celerius, quod falsissimum est[45]. Nec eaedem rationes in

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[43] By this word is meant the absorption of the liquor by the herb.

[44] Bacon was, of course, ignorant of the true theory of Dew, for which see Dr. Wells' remarkable Memoir on the Theory of Dew, reprinted by Longmans and Co., in 1866. Some account of Dr. Wells' researches is given in Herschel's Discourse on the Study of Natural Philosophy, §§ 163–9, and in Mill's Logic, bk. iii. ch. 9. § 3.

The following curious passage in the Historia Densi et Rari (E. and S., vol. ii. p. 291) is, perhaps, worth transcribing: 'Rores matutini sunt proculdubio vapores, qui in aerem purum non erant plene dissipati et versi, sed haerebant imperfecte misti, donec per frigora noctis, praesertim in regione media quam vocant aeris, fuerint repercussi, et in aquam condensati.' For another interesting passage, see Sylva Sylvarum, Exp. 81.

[45] This passage, compared with De Augmentis, v. 2 (E. and S., vol. i. p. 625), shews pretty conclusively that Bacon was acquainted with the experiments on falling bodies made by Galileo from the leaning tower of Pisa, though he nowhere mentions Galileo's name in connection with them. Indeed, the passage at the beginning of the second paragraph in the last Aphorism seems to shew that he was either imperfectly acquainted with these experiments or that he did not altogether accept the conclusions

omni genere virtutum valent, sed longe diversae. Itaque hae mensurae ex rebus ipsis petendae sunt, et non ex verisimilitudine aut conjecturis [46].

Denique in omni inquisitione naturae *Quantum* corporis requiratur ad aliquod effectum, tanquam dosis, notandum; et cautiones de *Nimis* et *Parum* aspergendae.

XLVIII.

Inter *praerogativas instantiarum* ponemus loco vicesimo quarto *Instantias Luctae;* quas etiam *Instantias Praedominantiae* appellare consuevimus [47]. Eae indicant praedominantiam et cessionem virtutum ad invicem; et quae ex illis sit fortior et vincat, quae infirmior et succumbat. Sunt enim motus et nixus corporum compositi, decompositi, et complicati, non minus quam corpora ipsa. Proponemus igitur primum species praecipuas motuum sive virtutum activarum; ut magis perspicua sit ipsarum comparatio in robore, et exinde demonstratio atque designatio *instantiarum luctae* et *praedominantiae.*

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drawn from them. On the whole subject, see note 24 on the last Aphorism.

[46] The necessity of bearing in mind Bacon's caution is well illustrated in the case of the expansion of water, as well as of bismuth and the casting-metals generally, which are, at certain temperatures, an exception to the general law that bodies expand with every increase in temperature. In a case like this, mere analogy might easily deceive us. See my Inductive Logic, 3rd Ed., pp. 137–8.

[47] 'By an oversight,' as Mr. Kitchin remarks, 'Bacon gives the same second name to these Instances as he does to the third class (Aph. 24), namely, "instantiae ostensivae * * * quas etiam elucescentias, sive instantias liberatas et *praedominantes*, appellare consuevimus."' By comparing the two sets of instances, it will be seen, however, that the word is used in totally different senses.

These 'Instantiae Luctae' or 'wrestling instances' (as they are best called) comprise what Bacon conceived to be the various conflicting kinds of motion. The discussion, as well as his use of the term 'Motion,' will often be found to be vague and unsatisfactory. The indestructibility of matter ('motus antitypiae materiae') and even the property of inertia itself ('motus decubitus, sive motus exhorrentiae motus') are included by him under this generic name. Motion, I need hardly say, ought, strictly speaking, to be used in the sense of 'change of place,' though it may legitimately be applied to changes in the relative positions of the

(1) Motus Primus sit Motus *Antitypiae*[48] materiae, quae inest in singulis portionibus ejus; per quem plane annihilari non vult: ita ut nullum incendium, nullum pondus aut depressio, nulla violentia, nulla denique aetas aut diuturnitas temporis possit redigere aliquam vel minimam portionem materiae in nihilum; quin illa et sit aliquid, et loci aliquid occupet, et se (in qualicunque necessitate ponatur), vel formam mutando vel locum, liberet, vel (si non detur copia) ut est subsistat; neque unquam res eo deveniat, ut aut nihil sit, aut nullibi[49]. Quem motum Schola (quae semper fere et denominat et definit res potius per effectus et incommoda quam per causas interiores) vel denotat per illud axioma, quod *Duo corpora non possint esse in uno loco;* vel vocat motum *Ne fiat penetratio dimensionum*[50]. Neque hujus motus exempla proponi consentaneum est: inest enim omni corpori.

(2) Sit Motus Secundus, Motus (quem appellamus) *Nexus;* per quem corpora non patiuntur se ulla ex parte sui dirimi a contactu alterius corporis, ut quae mutuo nexu et contactu gaudeant. Quem motum Schola vocat Motum *Ne detur vacuum*[51]*;* veluti cum aqua attrahitur sursum exuctione, aut

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parts of a body (for instance, of the molecules) as well as to changes of place of the entire body itself. The vague use of the term 'Motion' dates from Aristotle downwards. Aquinas, in the Summa, repeatedly says that any operation whatever may 'secundum similitudinem' be called motion.

This Aphorism was included in the little volume, entitled Historia Naturalis et Experimentalis, &c., published at Leyden in 1638. See Introduction, p. 143, note 62.

[48] Motion of reaction, resistance, or impenetrability. Cp. the use of the verb ἀντιτυπεῖν in Arist. Meteorologica, ii. 8 (p. 368 a. 3), iii. 1 (p. 370 b. 18, and 371 a. 25). In Sextus Empiricus, Pyrrh. Hypot. bk. iii. ch. 5, the incomprehensibility of body is founded on the incomprehensibility of ἀντιτυπία, and that on the incomprehensibility of touch.

[49] The 'Motus Antitypiae' or Indestructibility of matter is expressed in the adage 'in nihilum nil posse reverti.' See ii. 40, pp. 490–1, with notes 52, 53.

[50] Cp. ii. 36 (6). If there could be two bodies in one place, one of them would be annihilated, which is a contradiction in terms. Hence, both the axioms here referred to imply the indestructibility of matter.

[51] In the Phaenomena Universi (E. and S., vol. iii. p. 704) this is called 'Motus successionis, quem motum ne detur vacuum appellant.'

On Bacon's rejection of a vacuum, and his notion of 'Nature's abhor-

per fistulas; caro per ventosas[52]; aut cum aqua sistitur nec effluit in hydriis perforatis, nisi os hydriae ad immittendum aërem aperiatur; et innumera id genus.

(3) Sit Motus Tertius, Motus (quem appellamus) *Libertatis*[53]; per quem corpora se liberare nituntur a pressura aut tensura praeter-naturali, et restituere se in dimensum corpori suo conveniens. Cujus motus etiam innumera sunt exempla: veluti (quatenus ad liberationem a pressura) aquae in natando, aëris in volando; aquae in remigando, aëris in undulationibus ventorum; laminae in horologiis. Nec ineleganter se ostendit motus aëris compressi in sclopettis ludicris puerorum, cum alnum aut simile quiddam excavant, et infarciunt frusto alicujus radicis succulentae, vel similium, ad utrosque fines; deinde per embolum[54] trudunt radicem vel hujusmodi farcimentum in foramen alterum; unde emittitur et ejicitur radix cum sonitu ad foramen alterum, idque antequam tangatur a radice aut farcimento citimo, aut

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rence of a vacuum,' cp. i. 66 ad fin., ii. 8 ad init., with the notes on those passages. Mr. Ellis, in his Preface to the Historia Densi et Rari (E. and S., vol. ii. p. 238), remarks on the change which Bacon's opinions seem to have undergone on this subject between writing the Cogitationes de Rerum Natura and the essay on the fable of Cupid on the one hand, and the Historia Densi et Rari and the Novum Organum on the other. In the 'Canones' appended to the former of these two last works (E. and S., vol. ii. p. 303) he says: 'Non est vacuum in natura, nec congregatum nec intermistum.' But curiously enough, notwithstanding other passages in the Novum Organum to the contrary, he speaks doubtfully towards the end of this present Aphorism: 'Utrum vero motus nexus sit invincibilis, adhuc haeremus. Neque enim pro certo affirmaverimus, utrum detur vacuum, sive coacervatum, sive permistum.' See my notes on this passage (notes 61, 62, pp. 554–5).

[52] Cupping-glasses. The process of cupping has been explained in note 49 on Aph. 35. It may be remarked of all the phenomena referred to in this section that their explanation depends on a knowledge of the laws of atmospheric pressure. Of these, Bacon was ignorant.

[53] By the 'Motus Libertatis' Bacon means what in modern Physics is called Elasticity, a property common to all matter. It is the property in virtue of which bodies resume their original form or volume, when the force which altered that form or volume ceases to act. It may be developed in bodies by pressure, by traction or pulling ('tensura'), by flexion or bending, and by torsion or twisting.

[54] ἔμβολος, here used for a ramrod.

embolo[55]. Quatenus vero ad liberationem a tensura, ostendit se hic motus in aëre post exuctionem in ovis vitreis remanente[56], in chordis, in corio, et panno, resilientibus post tensuras suas, nisi tensurae illae per moram invaluerint, etc. Atque hunc motum Schola sub nomine Motus ex *Forma Elementi*[57] innuit: satis quidem inscite, cum hic motus non tantum ad aërem, aquam, aut flammam pertineat, sed ad omnem diversitatem consistentiae; ut ligni, ferri, plumbi, panni, membranae, etc., in quibus singula corpora suae habent dimensionis modulum, et ab eo aegre ad spatium aliquod notabile abripiuntur. Verum quia motus iste libertatis omnium est maxime obvius, et ad infinita spectans, consultum fuerit eum bene et perspicue distinguere. Quidam enim valde negligenter confundunt hunc motum cum gemino illo motu *antitypiae* et *nexus;* liberationem scilicet a pressura, cum motu *antitypiae;* a tensura, cum motu *nexus;* ac si ideo cederent aut se dilatarent corpora compressa, ne sequeretur *penetratio dimensionum;* ideo resilirent et contraherent se corpora tensa, ne sequeretur *vacuum.* Atqui si aër compressus se vellet recipere in densitatem aquae, aut lignum in densitatem lapidis, nil opus foret *penetratione dimensionum;* et nihilominus longe major posset esse compressio illorum, quam illa ullo modo patiuntur. Eodem modo si aqua se dilatare vellet in raritatem aëris, aut lapis in raritatem ligni, non opus foret *vacuo;* et tamen longe major posset fieri extensio eorum, quam illa ullo modo patiuntur. Itaque non reducitur res ad *penetrationem dimensionum* et *vacuum*, nisi in ultimitatibus condensationis et rarefactionis; cum tamen isti motus longe citra eas sistant et versentur, neque aliud sint quam desideria corporum conservandi se in consistentiis suis (sive, si malint, in formis suis), nec ab iis recedendi subito, nisi per modos suaves ac per consensum alterentur. At longe

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[55] This example also illustrates the amount of pressure which may be produced by the compression of air. Champagne bottles, soda-water bottles, &c., are familiar illustrations of the same fact.

[56] He alludes here to the unsatisfactory experiment made with the glass eggs, mentioned in Aph. 45. As I have said before, he was not aware that the phenomena there described are due to the pressure of the atmosphere.

[57] By this expression is meant the tendency of each of the Elements to preserve or recover the consistency which is proper to it.

magis necessarium est (quia multa secum trahit), ut intimetur hominibus, motum violentum (quem nos *mechanicum*, Democritus, qui in motibus suis primis expediendis etiam infra mediocres philosophos ponendus est, motum *plagae*[58] vocavit) nil aliud esse quam Motum Libertatis, scilicet a compressione ad relaxationem. Etenim in omni sive simplici protrusione sive volatu per aërem, non fit summotio aut latio localis, antequam partes corporis praeter-naturaliter patiantur et comprimantur ab impellente. Tum vero partibus aliis alias per successionem trudentibus, fertur totum[59]; nec solum progrediendo, sed etiam rotando simul; ut etiam hoc modo partes se liberare, aut magis ex aequo tolerare possint. Atque de hoc motu hactenus.

(4) Sit Motus Quartus, motus cui nomen dedimus Motus *Hyles*[60]: qui motus antistrophus est quodammodo Motui, de quo diximus, Libertatis. Etenim in Motu Libertatis, corpora novum dimensum sive novam sphaeram sive novam dilatationem aut contractionem (haec enim verborum varietas idem innuit) exhorrent, respuunt, fugiunt, et resilire ac veterem consistentiam recuperare totis viribus contendunt. At contra in hoc Motu Hyles, corpora novam sphaeram sive dimensum appetunt; atque ad illud libenter et propere, et quandoque valentissimo nixu (ut in pulvere pyrio) aspirant. Instrumenta autem hujus motus, non sola certe, sed potentissima, aut saltem frequentissima, sunt calor et frigus. Exempli gratia: aër, si per tensuram (velut per exuctionem in ovis vitreis[61]) dilatetur, magno laboret desiderio seipsum restituendi. At

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[58] See note 56 on Aph. 35, pp. 452–3. It is curious to find Bacon in the present passage depreciating Democritus, whom he usually rates so highly.

[59] Cp. Aph. 36 (6), where he adopts the same explanation of the motion of projectiles, 'motus missilium.'

[60] By this 'motus' is meant the tendency of matter to assume and retain a new form, by means of expansion or contraction, in contrast to its tendency, as noticed in the last section, to revert, after any temporary change, to its original form.

[61] On this example, cp. last section and see note 18 on Aph. 45. The pressure of the atmosphere (with which Bacon was unacquainted) would cause the air to rise within the egg, till the enclosed air assumed the same density as that without it.

admoto calore, e contra appetit dilatari, et concupiscet[62] novam sphaeram, et transit et migrat in illam libenter, tanquam in novam formam (ut loquuntur); nec post dilatationem nonnullam de reditu curat, nisi per admotionem frigidi ad eam invitetur; quae non reditus est, sed transmutatio repetita. Eodem modo et aqua, si per compressionem arctetur, recalcitrat[63]; et vult fieri qualis fuit, scilicet latior. At si interveniat frigus intensum et continuatum, mutat se sponte sua et libenter in condensationem glaciei; atque si plane continuetur frigus, nec a teporibus interrumpatur (ut fit in speluncis et cavernis paulo profundioribus), vertitur in crystallum[64] aut materiam similem, nec unquam restituitur.

(5) Sit Motus Quintus, Motus *Continuationis*[64a]. Intelligimus autem non continuationis simplicis et primariae, cum corpore aliquo altero (nam ille est Motus Nexus); sed continuationis sui, in corpore certo. Certissimum enim est, quod corpora omnia solutionem continuitatis exhorreant; alia magis, alia minus, sed omnia aliquatenus. Nam ut in corporibus duris (veluti chalybis, vitri) reluctatio contra discontinuationem est

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[62] This, which is the reading of the First Edition, is altered in the Second to concupiscit, obviously the right word.

[63] Cp. Bacon's abortive experiment on the leaden globe, as described in Aph. 45.

[64] See Pliny, Nat. Hist. xxxvii. 2 (9), sect. 23 (where he says 'glaciem esse certum est, unde nomen Graeci dedere'), and Seneca, Nat. Quaest. iii. 25 ad fin. Solinus (Polyhistor, cap. 15 ad fin.) combats this opinion. Mr. Ellis says: 'Though this account of the origin of crystals is of course erroneous, yet there is a class of crystals which have been shown to occupy the same volume which their water of crystallisation would occupy in the state of ice; so that their other constituents may in some sort be said to take up no space. This curious analogy with ice was proved by Playfair and Joule in a very considerable number of cases. See Phil. Mag. Dec. 1845.'

Bacon seems to be speaking of stalactites and stalagmites as well as of what are more commonly called crystals.

[64a] This is Cohesion, or the force which unites molecules of the same nature. 'The modern experiments on the strength of different substances, by finding what weights are necessary in order to tear them asunder, are founded on this property. These experiments have been made with bars of wood, metals, glass, &c., of given dimensions, and it has been found that the cohesive strength of a body is in the joint proportion of its elasticity, and toughness, and the area of its section.' Dr. Hippus in the Account of the Novum Organum in the Library of Useful Knowledge.

maxime robusta et valida, ita etiam in liquoribus, ubi cessare aut languere saltem videtur motus ejusmodi, tamen non prorsus reperitur privatio ejus[65]; sed plane inest ipsis in gradu tanquam infimo, et prodit se in experimentis plurimis; sicut in bullis, in rotunditate guttarum[66], in filis tenuioribus stillicidiorum[67], et in sequacitate corporum glutinosorum, et ejusmodi. Sed maxime omnium se ostendit appetitus iste, si discontinuatio tentetur usque ad fractiones minores. Nam in mortariis, post contusionem ad certum gradum, non amplius operatur pistillum; aqua non subintrat rimas minores; quin et ipse aër, non obstante subtilitate corporis ipsius, poros vasorum paulo solidiorum non pertransit subito, nec nisi per diuturnam insinuationem.

(6) Sit Motus Sextus, motus quem nominamus Motum *ad Lucrum*, sive Motum *Indigentiae*[68]. Is est, per quem corpora, quando versantur inter plane heterogenea et quasi inimica, si forte nanciscantur copiam aut commoditatem evitandi illa heterogenea et se applicandi ad magis cognata, (licet illa ipsa cognata talia fuerint quae non habeant arctum consensum cum ipsis) tamen statim ea amplectuntur, et tanquam potiora malunt: et lucri loco (unde vocabulum sumpsimus) hoc ponere

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[65] The force of cohesion is much stronger in solids than in liquids, while in gases it is overcome by that of repulsion.

[66] In large masses of liquids, the force of gravity overcomes that of cohesion, and the liquid takes no special shape, but assumes that of the vessel in which it is contained. But in smaller masses cohesion gets the upper hand, and the liquid then presents the spheroidal form. In the imaginary case of the particles being acted upon by the force of cohesion alone, the form assumed would be that of a perfect sphere.

[67] On the constitution of a jet of liquid issuing through a circular orifice, see Enc. Brit., last (9th) Ed., vol. v. p. 68, and, for a much more precise and detailed account, Daguin, Traité de Physique, 2nd Ed., tome i. pp. 243-51.

[68] Under this head Bacon seems to include cases of Adhesion, of Capillary Attraction, and of Chemical Affinity. Dr. Hippus gives a good instance of this 'motion of preference' in the case of mercury, 'the surface of which in a glass bottle appears convex, while, in a metallic vessel, it appears concave, in consequence of its tendency to adhere to the sides of the vessel, as it has a greater attraction for metal than glass.' The mercury, in fact, moistens the metallic surface, but does not moisten the glass surface. This example falls under the head of capillary phenomena.

videntur, tanquam talium corporum indiga. Exempli gratia: aurum, aut aliud metallum foliatum non delectatur aëre circumfuso. Itaque si corpus aliquod tangibile et crassum nanciscatur (ut digitum, papyrum, quidvis aliud), adhaeret statim, nec facile divellitur[69]. Etiam papyrus, aut pannus, et hujusmodi, non bene se habent cum aëre qui inseritur et commistus est in ipsorum poris. Itaque aquam aut liquorem libenter imbibunt, et aërem exterminant. Etiam saccharum, aut spongia infusa in aquam aut vinum, licet pars ipsorum emineat et longe attollatur supra vinum aut aquam, tamen aquam aut vinum paulatim et per gradus attrahunt in sursum[70].

Unde optimus canon sumitur aperturae et solutionum corporum. Missis enim corrosivis et aquis fortibus, quae viam sibi aperiunt, si possit inveniri corpus proportionatum et magis consentiens et amicum corpori alicui solido quam illud cum quo tanquam per necessitatem commiscetur, statim se aperit et relaxat corpus, et illud alterum intro recipit, priore excluso aut summoto[71]. Neque operatur aut potest iste *motus ad lucrum* solummodo ad tactum. Nam electrica operatio (de qua Gilbertus et alii post eum tantas excitarunt fabulas) non alia est quam corporis per fricationem levem excitati appetitus; qui aërem non bene tolerat, sed aliud tangibile mavult, si reperiatur in propinquo[72].

(7) Sit motus Septimus, Motus (quem appellamus) *Congregationis Majoris;* per quem corpora feruntur ad massas connaturalium suorum: gravia, ad globum terrae; levia, ad

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[69] This is an ordinary case of adhesion.

[70] These are capillary phenomena. The hostility to air, in all these examples, is, of course, a mere fancy.

[71] These are cases of what we should call Chemical Affinity. Any manual of chemistry will furnish abundant examples of what Bacon means. Thus, Chlorine decomposes bromide of silver, forming Chloride of silver, and eliminating bromine.

[72] This attack on Gilbert (whom, as we have seen before, Bacon treats in so varying a manner) and the superficial attempt at explaining the action of electricity are both worth noting. With regard to the cause of the production of electricity by friction, nothing is known. Electricity may also be produced by other means, as by chemical action, heat, &c.

ambitum coeli[73]. Hunc Schola nomine *Motus Naturalis*[74] insignivit: levi contemplatione, quia scilicet nil spectabile erat ab extra quod eum motum cieret (itaque rebus ipsis innatum atque insitum putavit); aut forte quia non cessat. Nec mirum: semper enim praesto sunt coelum et terra; cum e contra causae et origines plurimorum ex reliquis motibus interdum absint, interdum adsint. Itaque hunc, quia non intermittit sed caeteris intermittentibus statim occurrit, perpetuum et proprium; reliquos ascititios posuit. Est autem iste motus revera satis infirmus et hebes, tanquam is qui (nisi sit moles corporis major) caeteris motibus, quamdiu operantur, cedat et succumbat. Atque cum hic motus hominum cogitationes ita impleverit ut fere reliquos motus occultaverit, tamen parum est quod homines de eo sciunt, sed in multis circa illum erroribus versantur.

(8) Sit Motus Octavus, Motus *Congregationis Minoris;* per quem partes homogeneae in corpore aliquo separant se ab heterogeneis, et coëunt inter sese[75]; per quem etiam corpora integra ex similitudine substantiae se amplectuntur et fovent, et quandoque ad distantiam aliquam congregantur, attrahuntur, et conveniunt[76]: veluti cum in lacte flos lactis post moram aliquam supernatat; in vino faeces et tartarum subsidunt[77]. Neque enim haec fiunt per motum gravitatis et levitatis tantum, ut aliae partes summitatem petant, aliae ad imum vergant; sed multo magis per desiderium homo-

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[73] Cp. i. 66; ii. 35; 36 (3); 45; 46, with the notes on the various passages. The concluding observations of this section are very remarkable, when viewed in the light of the discoveries to be made towards the end of the century by Newton.

[74] On the distinction between Natural and Violent Motion, see i. 66; ii. 36 (6), with note 51 on the former Aphorism.

[75] These phenomena may all be referred to chemical affinity, to capillary attraction, or to the processes of mechanical distribution dependent on variations in size, form, weight, or specific gravity. Sometimes it may be a question to which of these causes a phenomenon may be due.

[76] A good instance would be that of two corks, both wet or both dry, floating near each other on water. For an explanation of this phenomenon, see Everett's Translation of Deschanel's Nat. Phil. Pt. i. p. 136, or Daguin, Traité de Physique, Tome i. pp. 209–10 2ème Ed.).

[77] In both cases, the phenomenon is due to differences of specific gravity, the lighter particles rising to the top, and the heavier falling to the bottom.

geneorum inter se coeundi et se uniendi[78]. Differt autem iste motus a motu *indigentiae*, in duobus. Uno, quod in motu *indigentiae* sit stimulus major naturae malignae et contrariae; at in hoc motu (si modo impedimenta et vincula absint) uniuntur partes per amicitiam, licet absit natura aliena quae litem moveat: altero, quod arctior sit unio, et tanquam majore cum delectu. In illo enim, modo evitetur corpus inimicum[79], corpora etiam non admodum cognata concurrunt; at in hoc coëunt substantiae, germana plane similitudine devinctae, et conflantur tanquam in unum. Atque hic motus omnibus corporibus compositis inest; et se facile conspiciendum in singulis daret, nisi ligaretur et fraenaretur per alios corporum appetitus et necessitates, quae istam coitionem disturbant.

Ligatur autem motus iste plerumque tribus modis: torpore corporum; fraeno corporis dominantis; et motu externo. Ad torporem corporum quod attinet; certum est inesse corporibus tangibilibus pigritiam quandam[80] secundum magis et minus, et exhorrentiam motus localis; ut, nisi excitentur, malint statu

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[78] An excellent illustration of Bacon's meaning may be found in the commonly received opinion with regard to the formation of flint nodules. See Phillips' Manual of Geology, pp. 358–9, or Page's Advanced Text Book of Geology, 6th Ed., pp. 350–4. The latter author discusses the question at some length, and concludes: 'From these facts it would seem that flints are aggregations of silex round some organic nucleus, just like the ironstone septaria of the coal-shales, the grains of the oolite, the ironstone nodules of the gault—all of which are aggregations round some organic centre, be it a fragment of plant, a shell, a tooth, coprolite, or other organism. This is now the generally received opinion; and when it is remembered that the organisms must have been deposited when the chalk was in a flocculent and pulpy state, there can be little difficulty in conceiving how the silex, held in solution by the waters of deposit, would, by chemical affinity, attach itself to the decaying organism.' Dr. Bowerbank applies a similar theory even to beds of tabular flint, supposing that the sponges originating the deposit had developed themselves laterally, and that, approaching and touching each other, they united and thus formed extensive and continuous beds. On the formation of nodules generally, see also Lyell's Student's Elements of Geology, 2nd Ed., p. 40.

[79] As we have seen under 'Motus Sextus,' this idea of the 'corpus inimicum' is, in many cases, fanciful.

[80] This is the property of *inertia*, and it is worth noting that Bacon refers to it; but it must be remembered that this property, as we conceive it, applies equally to moving bodies, which would go on moving for ever, if there were nothing external to stop them.

suo (prout sunt) esse contenta quam in melius se expedire. Discutitur autem iste torpor triplici auxilio: aut per calorem, aut per virtutem alicujus cognati corporis eminentem[81], aut per motum vividum et potentem. Atque primo quoad auxilium caloris; hinc fit, quod calor pronuntietur esse illud quod *separet heterogenea, congreget homogenea.* Quam definitionem Peripateticorum merito derisit Gilbertus; dicens eam esse perinde ac si quis diceret ac definiret hominem illud esse quod serat triticum et plantet vineas: esse enim definitionem tantum per effectus, eosque particulares[82]. Sed adhuc magis culpanda est illa definitio; quia etiam effectus illi (quales quales sunt) non sunt ex proprietate caloris, sed tantum per accidens[83] (idem enim facit frigus, ut postea dicemus[84]), nempe

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[81] Taking this phrase as intended to include magnetism and, so far as Bacon had any conception of it, Gravity, we ought to add Light, Electricity, and Chemical Action.

[82] 'For the definition we may refer to the Margarita Philosophiae, xi. 3.' [It should be ix. 3. The passage runs thus: 'Calidum est quod homogenia id est entia ejusdem naturae congregat et heterogenia id est diversarum naturarum entia segregat.' The true title of the book is Margarita Philosophica, to which, in later Editions, 'Nova' is added.] 'It is founded on a passage in the De Gen. et Corr. ii. 2' [p. 329 b. 26–30]. 'Gilbert's censure on it is to be found in his posthumous work De Mundo nostro sublunari Philosophia nova, which was published by Gruter in 1651, long after the death of Bacon. It seems however, as Gruter remarks, that the work, which he suggests may have been written before the treatise De Magnete, published in 1600, had been read in manuscript by "viri magni et famae celeberrimae." "Illi perspicace in Physicis praesertim ingenio haud poenitendae in evolvendo operae testimonium dederunt, quod integrum excussisse censeantur, et aliqua a vulgaribus opinionibus abhorrentia calculo suo comprobata hinc sparsim citent;" in which I do not doubt that Gruter refers to Bacon. Bacon's quotation seems to have been made from imperfect memory, as the words of the original are:—"quid illud ostendit aut quae illa differentia ab effectu tantum in quibusdam corporibus, *congregans homogenea et disgregans heterogenea?* ac si diceres hominem animal esse carduos et sentes evellens, et fruges serens, cum istud sit agricolae studium." – De Mundo, &c., i. c. 26.' Mr. Ellis' note.

[83] That is to say 'are not peculiar to heat, but result only accidentally, through the instrumentality of that agent; the true cause being the desire in the homogeneous parts of coming together.' To understand the reason given by Bacon, 'idem enim facit frigus,' we must recollect that the definition of 'proprium,' in the Text-books of his time, was 'quod convenit omni, soli, et semper.'

[84] See the next paragraph. It need hardly be repeated that Bacon had

ex desiderio partium homogenearum coëundi, adjuvante tantum calore ad discutiendum torporem, qui torpor desiderium illud antea ligaverat. Quoad vero auxilium virtutis inditae a corpore cognato; illud mirabiliter elucescit in magnete armato, qui excitat in ferro virtutem detinendi ferrum per similitudinem substantiae, discusso torpore ferri per virtutem magnetis. Quoad vero auxilium motus; conspicitur illud in sagittis ligneis, cuspide etiam lignea, quae altius penetrant in alia ligna quam si fuissent armatae ferro, per similitudinem substantiae, discusso torpore ligni per motum celerem: de quibus duobus experimentis etiam in aphorismo de *instantiis clandestinis* diximus [85].

Ligatio vero motus *congregationis minoris*, quae fit per fraenum corporis dominantis, conspicitur in solutione sanguinis et urinarum [86] per frigus. Quamdiu enim repleta fuerint corpora illa spiritu agili [87], qui singulas eorum partes cujuscunque generis ipse ut dominus totius ordinat et cohibet, tamdiu non coëunt heterogenea [88] propter fraenum; sed postquam ille spiritus evaporaverit, aut suffocatus fuerit per

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no idea of the true relation of heat and cold, as different degrees of the same phenomenon. The phrase 'change of temperature' would include both, and it might have supplied him with a key to his difficulties.

[85] See ii. 25 ad fin., with notes.

[86] With regard to urine, as affected by cold, see Dr. Watson's Lectures on the Principles and Practice of Physic, 5th Ed., Lect. 70, vol. ii. p. 702.

As to blood, Bacon is in error. 'So far from coagulation being promoted by cold,' says Dr. Carpenter (Principles of Human Physiology, 8th Ed., p. 272), 'it can be shown to be accelerated by moderate warmth, the natural heat of the body from which the blood is taken appearing to be most favourable to it; but the coagulating power appears to be destroyed by a temperature of about 150°, blood heated to that point remaining permanently fluid.' Bacon was, of course, deceived by seeing the blood gradually coagulate after being taken from the body, the decreasing temperature, which was only a concomitant of coagulation, occurring to him as the cause.

[87] It is needless to add anything to what I have already said on Bacon's conception of 'spirit' in the notes on i. 50, ii. 40, and elsewhere.

[88] This word should, perhaps, be 'homogenea,' as Mr. Ellis suggests. But 'heterogenea' seems intelligible enough, in the sense of 'different parts.' Cp. the expression 'omnia solvuntur et redeunt in heterogeneas suas, sive (si placet) elementa sua;' in the passage referred to just below.

frigus, tum solutae partes a fraeno coëunt secundum desiderium suum naturale. Atque ideo fit, ut omnia corpora quae continent spiritum acrem (ut sales, et hujusmodi) durent et non solvantur, ob fraenum permanens et durabile spiritus dominantis et imperiosi.

Ligatio vero motus *congregationis minoris,* quae fit per motum externum, maxime conspicitur in agitationibus corporum per quas arcetur putrefactio. Omnis enim putrefactio fundatur in congregatione homogeneorum [89]; unde paulatim fit corruptio prioris (quam vocant) formae, et generatio novae [90]. Nam putrefactionem, quae sternit viam ad generationem novae formae, praecedit solutio veteris; quae est ipsa coitio ad homogeniam. Ea vero, si non impedita fuerit, fit solutio simplex: sin occurrant varia quae obstant, sequuntur putrefactiones quae sunt rudimenta generationis novae. Quod si (id quod nunc agitur) fiat agitatio frequens per motum externum, tum vero motus iste coitionis (qui est delicatus et mollis et indiget quiete ab externis) disturbatur et cessat; ut fieri videmus in innumeris: veluti cum quotidiana agitatio aut profluentia aquae arceat putrefactionem; venti arceant pestilentiam aëris; grana in granariis versa et agitata maneant pura; omnia denique agitata exterius non facile putrefiant interius.

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[89] Cp. Historia Vitae et Mortis, E. and S., vol. ii. p. 214. This remark shews how little Bacon was acquainted with organic chemistry. 'Putrefaction' (I quote from Dr. Ure's Dictionary of Arts, Manufactures, &c.) 'is the spontaneous decomposition of albuminoid or protein and gelatine compounds, when exposed to a limited amount of air. It is the decomposition of bodies containing nitrogen, called by some persons azotised bodies; although such bodies are produced only by life, are the principal means of producing life, and are more fitly called zoogens.'

'Thus bodies decompose at any temperature between 32° and 140° Fahrenheit (0°—60° C.). Their decomposition begins by the action of the oxygen of the air, so that a partial oxidation and a gradual disruption are simultaneous. The result of this is a number of liquid and gaseous compounds: carbonic acid, hydrogen, nitrogen, ammonia, sulphuretted hydrogen, phosphuretted hydrogen, carburetted hydrogen, acetic acid, lactic acid,' &c.

On 'Experiments touching the inducing and accelerating, the prohibiting and preventing putrefaction,' see Sylva Sylvarum, Exps. 328–51.

[90] On the theory of 'Spontaneous Generation,' see ii. 41 and note 76.

Superest ut non omittatur coitio illa partium corporum, unde fit praecipue induratio et desiccatio. Postquam enim spiritus, aut humidum in spiritum versum, evolaverit in aliquo corpore porosiore (ut in ligno, osse, membrana, et hujusmodi), tum partes crassiores majore nixu contrahuntur et coëunt, unde sequitur induratio aut desiccatio[91]: quod existimamus fieri, non tam ob motum *nexus*, ne detur vacuum, quam per motum istum amicitiae et unionis.

Ad coitionem vero ad distans quod attinet, ea infrequens est et rara; et tamen in pluribus inest quam quibus observatur. Hujus simulacra sunt, cum bulla solvat bullam[92]; medicamenta ex similitudine substantiae trahant humores[93]; chorda in diversis fidibus ad unisonum moveat chordam[94]; et hujusmodi. Etiam in spiritibus animalium hunc motum vigere existimamus[95], sed plane incognitum. At eminet certe in magnete, et ferro excito. Cum autem de motibus magnetis loquimur, distinguendi plane sunt. Quatuor enim virtutes sive operationes sunt in magnete, quae non confundi, sed separari debent; licet admiratio hominum et stupor eas commiscuerit. Una, coitionis magnetis ad magnetem, vel ferri ad magnetem, vel ferri exciti ad ferrum. Secunda, verticitatis ejus ad septentriones et austrum, atque simul declinationis ejus[96]. Tertia, penetrationis ejus per aurum,

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[91] Cp. ii. 40: 'Spiritus in re tangibili, emissus, corpora contrahit et desiccat.' This position is expanded in the following paragraph, beginning 'Etenim in omni corpore,' &c.

[92] This is the case when two bubbles come into contact, and is due, amongst other causes, to Capillary Attraction. See p. 419, note 65.

[93] This is an example of the False Analogies of which ancient medicine was so full, and is a special application of the maxim 'Similia similibus curantur.' We find the opposite sentiment in Arist. Eth. ii. 2 (p. 1104 b. 17, 18): *αἱ δὲ ἰατρεῖαι διὰ τῶν ἐναντίων πεφύκασι γίνεσθαι.*

[94] The sympathetic vibrations of strings, tuning-forks, &c., in unison, are well-known phenomena. See Tyndall's Lectures on Sound, Lect. 8 ad fin. (ch. 9 in later editions), or, for a more detailed account, Helmholtz on the Sensations of Tone, Translation by Mr. Ellis, Pt. i. ch. 3.

[95] See Sylva Sylvarum, Exp. 1000; De Augmentis, lib. iv. cap. 3 (E. and S., vol. i. pp. 608–9). Both these passages are well worth consulting.

[96] These and the other phenomena which Bacon notices are fully described by Gilbert, De Magnete.

vitrum, lapidem, omnia[97]. Quarta, communicationis virtutis ejus de lapide in ferrum, et de ferro in ferrum, absque communicatione substantiae. Verum hoc loco de prima virtute ejus tantum loquimur, videlicet coitionis. Insignis etiam est motus coitionis argenti vivi et auri[98]: adeo ut aurum alliciat argentum vivum, licet confectum in unguenta; atque operarii inter vapores argenti vivi soleant tenere in ore frustum auri, ad colligendas emissiones argenti vivi, alias crania et ossa eorum invasuras; unde etiam frustum illud paulo post albescit. Atque de motu *congregationis minoris* haec dicta sint.

(9) Sit Motus Nonus, *Motus Magneticus;* qui licet sit ex genere motus *congregationis minoris*[99], tamen si operetur ad distantias magnas et super massas rerum magnas, inquisitionem meretur separatam; praesertim si nec incipiat a tactu, quemadmodum plurimi, nec perducat actionem ad tactum, quemadmodum omnes motus congregativi; sed corpora tantum elevet, aut ea intumescere faciat, nec quicquam ultra. Nam si luna attollat aquas[1], aut turgescere aut intumescere faciat humida[2]; aut coelum stellatum attrahat planetas versus sua apogaea; aut sol alliget astra Veneris et Mercurii[3], ne longius absint a corpore ejus quam ad

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[97] See Aph. 42 ad init.

[98] The phenomena which Bacon noticed are due to the facts that, even at ordinary temperatures, Mercury is slightly volatile, and that the smallest quantity of mercurial vapour coming in contact with gold is sufficient to turn it white. It is, however, true that mercury combines very readily with gold, and hence it is used for the purpose of extracting that metal from the ore.

[99] It is curious to observe that it never occurred to Bacon, as it did afterwards to Newton, that the phenomena here described belong to the same class as those included under the 'Motus Congregationis Majoris.'

[1] See ii. 45 and notes 6, 7, both for this passage and for the one below on the attraction of the planets by the coelum stellatum.

[2] Cp. Historia Densi et Rari (E. and S., vol. ii. p. 266): 'Recepta est opinio, humores et succos, non in animalibus tantum sed et in plantis, sub pleniluniis magis turgescere, et cava implere.' Cp. Cicero, De Divinatione, ii. 14; Pliny, Nat. Hist. ii. 99, 101 (102, 104), sects. 201, &c.; Horace, Sat. ii. 4, l. 30:

'Lubrica nascentes implent conchylia Lunae.'

[3] The two inferior planets, or those whose orbits are nearer to the sun

distantiam certam; videntur hi motus nec sub *congregatione majore* nec sub *congregatione minore* bene collocari, sed esse tanquam congregativa media et imperfecta, ideoque speciem debere constituere propriam.

(10) Sit Motus Decimus, *Motus Fugae*[4]; motus scilicet

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than that of the earth. Whether referred to the heliocentric or geocentric system, the peculiarities of these planets early attracted attention. On the geocentric hypothesis, it was doubted whether their orbits were superior or inferior to that of the sun. Bacon starts various questions with regard to them in the Descriptio Globi Intellectualis (E. and S., vol. iii. pp. 746–7).

As to the words 'ne longius absint' &c., the best commentary on them will be found in Herschel's Outlines of Astronomy, § 467, &c. Herschel begins his account of the motions of these planets almost in the very words of Bacon: 'Two of the planets—Mercury and Venus—perform their circuit evidently as attendants upon the sun, from whose vicinity they never depart beyond a certain limit.'

[4] The following excellent remarks on this section are made by Dr. Hippus in his Account of the Novum Organum in the Library of Useful Knowledge: '*Motus fugae*, or the *motion of avoidance*, though very crudely and almost ludicrously illustrated by Bacon, has its foundation in fact, and is that property of matter which is now called *repulsion*. Newton found that a convex *lens*, when put upon a flat glass, remained at the distance of the $\frac{1}{137}$th part of an inch; and that a very considerable force was requisite to diminish this distance. Again, though steel is so much heavier than its bulk of water, yet if a dry *needle* be placed carefully upon the surface of a basin of water, it will float; the repulsion of the water preventing its sinking. Also the particles of all *gases* seem to repel each other, as appears from their elasticity. According to Boscovich, the atoms of which bodies are composed are capable of acting on each other with a force, which differs in intensity, and in kind, according to the distance. At sensible distances the force is *attractive*, and diminishes inversely as the squares of the distance. At the smallest distances the force is *repulsive*; it increases as the distance diminishes; and at last becomes infinite or insuperable. Hence if Boscovich's theory be correct, absolute contact, however paradoxical this may appear, is impossible. Facts, at all events, prove, in many cases, a repulsive power, whatever be its precise laws; and to these facts may be added, though somewhat differing from the former examples, the repulsion of electrified pith balls; also of the similar poles of two magnets. In the latter case, all the force of a strong man has proved insufficient to make the two north poles touch each other.' Other instances might be found in the fact that some chemical elements, so far as we know at present, will not combine with other elements (as, for instance, oxygen with fluorine), while others only combine with great difficulty; or, again, in certain phenomena of repulsion partly due to capillarity, as, for example, in the fact,

motui *congregationis minoris* contrarius; per quem corpora ex antipathia fugiunt et fugant inimica, seque ab illis separant, aut cum illis miscere se recusant. Quamvis enim videri possit in aliquibus hic motus esse motus tantum per accidens aut per consequens, respectu motus *congregationis minoris*, quia nequeunt coire homogenea, nisi heterogeneis exclusis et remotis; tamen ponendus est motus iste per se, et in speciem constituendus, quia in multis appetitus *fugae* cernitur magis principalis quam appetitus coitionis.

Eminet autem hic motus insigniter in excretionibus animalium; nec minus etiam in sensuum nonnullorum odiosis objectis, praecipue in olfactu et gustu. Odor enim foetidus ita rejicitur ab olfactu, ut etiam inducat in os stomachi motum expulsionis per consensum; sapor amarus et horridus ita rejicitur a palato aut gutture, ut inducat per consensum capitis conquassationem et horrorem. Veruntamen etiam in aliis locum habet iste motus. Conspicitur enim in antiperistasibus[5] nonnullis; ut in aëris media regione, cujus frigora videntur esse rejectiones naturae frigidae ex confiniis coelestium; quemadmodum etiam videntur magni illi fervores et inflammationes, quae inveniuntur in locis subterraneis, esse rejectiones naturae calidae ab interioribus terrae[6]. Calor enim et frigus, si fuerint in

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analogous to that of the needle, that insects can often move on the surface of water without sinking, or that a dry ball and a moistened ball, if placed on a liquid in such a manner that the curved surfaces of the liquid in their respective neighbourhoods intersect, will repel each other.

[5] See ii. 12 (Inst. 24), and 27, with note 94 on the latter Aphorism.

[6] It is curious to find all this nonsense adopted by Bacon. It is borrowed from Telesius (see De Principiis atque Originibus, E. and S., vol. iii. pp. 109–10). Cp., for similar notions, Arist. Meteorologica, i. 12 (p. 348 b. 2, κ.τ.λ.).

One of the Peripatetic doctrines (for which see Arist. De Gen. et Corr. ii. 3) was that fire is hot and dry, air hot and moist, water cold and moist, earth cold and dry. It required, therefore, to be explained why 'the middle region of the air' is cold and why 'subterraneous places' are warm, both phenomena being contrary to what might have been expected. Telesius (whom Bacon so frequently follows) adopted so much of the Peripatetic theory, as to make the heavens the principal seat of heat and the earth of cold. See the account of Telesius' philosophy in the De Principiis atque Originibus (p. 94, &c.), and cp. Telesius, De Rerum Natura, lib. i. capp. 1–3.

quanto minore, se invicem perimunt; sin fuerint in massis majoribus et tanquam justis exercitibus, tum vero per conflictum se locis invicem summovent et ejiciunt. Etiam tradunt cinamomum et odorifera, sita juxta latrinas et loca foetida, diutius odorem retinere; quia recusant exire et commisceri cum foetidis. Certe argentum vivum, quod alias se reuniret in corpus integrum, prohibetur per salivam hominis, aut axungiam[7] porci, aut terebinthinam, et hujusmodi, ne partes ejus coëant; propter malum consensum quem habent cum hujusmodi corporibus; a quibus undique circumfusis se retrahunt; adeo ut fortior sit earum *fuga* ab istis interjacentibus quam desiderium uniendi se cum partibus sui similibus; id quod vocant *mortificationem*[8] argenti vivi. Etiam quod oleum cum aqua non misceatur, non tantum in causa est differentia levitatis, sed malus ipsorum consensus: ut videre est in spiritu vini, qui cum levior sit oleo, tamen se bene miscet cum aqua. At maxime omnium insignis est motus *fugae* in nitro, et hujusmodi corporibus crudis, quae flammam exhorrent[9]; ut in pulvere pyrio, argento vivo, necnon in auro[10]. *Fuga* vero ferri[11] ab altero polo magnetis a Gilberto[12] bene notatur

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[7] Axle-tree grease, hog's lard. See Pliny, Nat. Hist. xxviii. 9 (37), sects. 135, &c.

[8] Cp. Historia Densi et Rari, E. and S., vol. ii. pp. 286–7.

[9] Cp. ii. 36 (7).

[10] Cp. Historia Ventorum, E. and S., vol. ii. p. 74, and see Beckmann's History of Inventions, vol. iii. p. 128 (as quoted in E. and S.) for an account of the discovery of fulminating gold. In the two-volume Edition, the reference is vol. ii. p. 301, &c. The effects of detonating silver are much more violent than those of detonating gold.

[11] That is, magnetised iron; for the law that 'Poles of the same name repel, and poles of contrary name attract one another' applies only to substances both of which are magnets.

[12] 'Ita coitio magnetica actus est magnetis et ferri, non actio unius, utriusque *ἐντελέχεια* non *ἔργον*, *συντελέχεια* et conactus potius quam sympathia; antipathia nulla est proprie magnetica. Nam fuga et declinatio terminorum, sive conversio totius, utriusque actus est ad unitatem, a conactu et *συνεντελέχεια* [sic] amborum.' Gilbert, De Magnete, lib. ii. cap. 4. But surely this is as much a case of repulsion as any of the others which have been noticed. Faraday (Experimental Researches in Electricity) has shewn that there are many substances (called by him diamagnetic substances) which are repelled by both poles of a magnet.

non esse *fuga* propria, sed conformitas, et coitio ad situm magis accommodatum.

(11) Sit Motus Undecimus, Motus *Assimilationis*, sive *Multiplicationis sui*, sive etiam *Generationis Simplicis*. *Generationem* autem *simplicem* dicimus non corporum integralium, ut in plantis, aut animalibus; sed corporum similarium [13]. Nempe per hunc motum corpora similaria vertunt corpora alia affinia, aut saltem bene disposita et praeparata, in substantiam et naturam suam: ut flamma, quae super halitus et oleosa multiplicat se, et generat novam flammam [14]; aër, qui super aquam et aquea multiplicat se, et generat novum aërem [15]; spiritus vegetabilis et animalis, qui super tenuiores

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[13] This is a curious limitation. The subject proposed for enquiry is not the process by which the life of the whole animal or plant is sustained, but the process by which and the materials out of which the separate parts (as the bone, muscles, flesh, &c.) are repaired or augmented. Bacon's ignorance of organic chemistry renders the discussion almost worthless.

[14] On the physical constitution of flame, and the means by which it is sustained or augmented (on which points Bacon was, of course, ignorant), see Tyndall's Heat a Mode of Motion, 2nd Ed., § 49, &c., or Watts' Dictionary of Chemistry, article 'Combustion,' already referred to in the note on ii. 36 ad fin. Cp. also the whole of the passage on Flame in ii. 36 (8), with the notes upon it.

[15] The transmutability of the Elements was one of the leading doctrines of the Peripatetic school. The student will find a clear and succinct statement of the theory in Arist. De Gen. et Corr. ii. 4 (p. 331). The conversion of water into air requires only the change of one quality, namely of 'cold' into 'warm,' the 'moist' being already common to the two. The intimate relation between air and water is spoken of in a variety of ways. Thus in Phys. iv. 5 (p. 213 a. 1–4), Aristotle says (in a passage already quoted): *οὕτω δὲ καὶ ἀὴρ ἔχει πρὸς ὕδωρ· οἷον ὕλη γάρ, τὸ δὲ εἶδος, τὸ μὲν ὕδωρ ὕλη ἀέρος, ὁ δὲ ἀὴρ οἷον ἐνέργειά τις ἐκείνου· τὸ γὰρ ὕδωρ δυνάμει ἀήρ ἐστιν, ὁ δ' ἀὴρ δυνάμει ὕδωρ ἄλλον τρόπον.* See also a curious discussion in Meteorologica, i. 3 (339 a–341 a). Seneca (Nat. Quaest. iii. 10) has a striking passage on the constant interchange of the elements.

Patricius, who attacks the doctrine of the transmutability of the elements (Discuss. Peripatet. tom. iv. lib. 3. pp. 395–6), asks very pertinently, who ever saw air converted into water, or water into air. 'Dicat mihi de numero istorum philosophorum aliquis, an unquam viderint, observarint, aërem in aquam converti? Scio ego, vidi, concedam, ex aqua et terra in aërem vapores ascendere, aërem eos fieri nemo unquam vidit. * * * * * * At dixit [Aristoteles] aërem in aquam transmutari. Scio eum dixisse, sed experimentum cur non attulit? Adferant sui pro eo.'

Bacon's idea seems to have been that air renews itself, and feeds, as

partes tam aquei quam oleosi in alimentis suis multiplicat se, et generat novum spiritum[16]; partes solidae plantarum et animalium, veluti folium, flos, caro, os, et sic de caeteris, quae singulae ex succis alimentorum assimilant et generant substantiam successivam et epiusiam[17]. Neque enim quenquam cum Paracelso delirare juvet, qui (distillationibus suis scilicet occaecatus) nutritionem per separationem tantum fieri voluit; quodque in pane vel cibo lateat oculus, nasus, cerebrum, jecur[18]; in succo terrae radix, folium, flos. Etenim sicut

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it were, on water, as flame renews itself and feeds on 'vapours and oily matter.'

Air itself, on the other hand, while in the lower regions, he appears to have regarded as a fixed body, which does not admit of resolution. 'Aër autem corpus fixum est, nec solvitur: licet enim aër ex humido aqueo novum aërem gignat, tamen vetus aër nihilominus manet; unde fit superoneratio illa aëris, de quo diximus in titulo de Ventis.' Hist. Vitae et Mortis, as quoted in the next note. Cp. Historia Ventorum, E. and S., vol. ii. pp. 42–3; 75. But, in the upper regions, it is resolved again into water, this 'reciprocation' being a necessary conclusion 'ex conservatione rerum.' See Historia Densi et Rari, E. and S., vol. ii. p. 293.

[16] On this absurd notion, cp. Historia Vitae et Mortis, Canon 32, E. and S., vol. ii. pp. 225–6.

[17] ἐπιούσιον, sufficient for the day, or proper for their sustenance. The word is, of course, adopted from the Lord's Prayer (Matt. vi. 11; Luke xi. 3). On the various opinions as to the meaning and derivation of this word, the two translations in the Vulgate (supersubstantialem—quotidianum), and the celebrated dispute thence arising between St. Bernard and Abelard (see Morison's St. Bernard, 1st Ed., p. 313, &c.), it would be travelling beyond my present province to speak.

[18] I borrow, with slight additions, the following note from Mr. Ellis: 'I have not been able to find any passage in Paracelsus which altogether corresponds to this remark; and in his Modus Pharmacandi the process of digestion is described without reference to the Archeus; nor is it said that each member "latet in pane vel cibo." "Hoc scimus, quod cujusque membri nutrimentum latitet in pane, carne, et in aliis similiter." "Quot vero modis et quibus, necnon qua ratione membris corporis nutrimentum dividatur, nos ignoramus; hoc tantum scimus, rem ita se habere ut diximus."—De Mod. Pharm. [Operum medico-chimicorum sive paradoxorum tomi undecim genuini, tom.] v. p. 233. (I use the edition of 1603.)

'Bacon has, however, correctly stated the general doctrine that alimentation is by separation; and again Paracelsus affirms that "officium vero Archei est in microcosmo purum ab impuro separare" [rather *sequestrare*]. —De Morbis Tartareis, [tom.] iii. 195. The truth is that Paracelsus's views

faber ex rudi massa lapidis vel ligni, per separationem et rejectionem superflui, educit folium, florem, oculum, nasum, manum, pedem, et similia; ita *Archaeum* illum Fabrum[19] internum ex alimento per separationem et rejectionem educere singula membra et partes asserit ille. Verum missis nugis, certissimum est partes singulas, tam similares quam organicas, in vegetabilibus et animalibus, succos alimentorum suorum fere communes, aut non multum diversos, primo attrahere cum nonnullo delectu, deinde assimilare, et vertere in naturam suam. Neque assimilatio ista, aut generatio simplex, fit solum in corporibus animatis, verum et inanimata ex hac re participant; veluti de flamma et aëre dictum est. Quinetiam spiritus emortuus[20], qui in omni tangibili animato continetur, id perpetuo agit, ut partes crassiores digerat et vertat in spiritum, qui deinde exeat; unde fit diminutio ponderis et exsiccatio, ut alibi diximus[21]. Neque etiam respuenda est in *assimilatione* accretio illa, quam vulgo ab alimentatione

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are so often repeated and varied in the course of his writings, that it is difficult to know how far his opinions are represented by any particular passage.

'It is well to remark that, to a certain extent, the theory here so decidedly condemned has, by the recent progress of organic chemistry, been shown to be true. Nothing seems better established than that the nitrogenised components of animal bodies are derived from the corresponding elements of their food. With respect to fat, it is, I believe, a prevailing opinion at present, that animals have the power of converting into it the starch or sugar of their food [see Miller's Organic Chemistry, Elements of Chemistry, 4th Ed., vol. iii. § 1718]; and the production of butyric acid by fermentation has been regarded as at least an illustration of the transformation. One of the highest authorities on such a subject, however, I mean M. Boussingault, was, at least a few years ago, of a different opinion. He regarded animal fat as the representative of the fatty matters contained in the food.'

[19] Paracelsus is very fond of this analogy. Thus, in the De Morbis Tartareis, cap. 3, he says: 'Ac insuper Archaeum loco et vice fabri praesto esse debeat.' Hallam (History of Literature, part i. ch. 7. §§ 17–20) gives a short account of the whimsical theories of Paracelsus. For a longer account, see Sprengel, Geschichte der Arzneykunde, Th. iii. Kap. 10.

[20] On the distinction between the 'spiritus mortualis' and the 'spiritus vitalis,' see Historia Vitae et Mortis, E. and S., vol. ii. pp. 214–7. In Canons vii, viii, he makes the same remarks as in the present passage.

[21] See ii. 40.

distinguunt; veluti cum lutum[22] inter lapillos concrescit, et vertitur in materiam lapideam; squammae circa dentes vertuntur in substantiam non minus duram quam sunt dentes ipsi, etc. Sumus enim in ea opinione, inesse corporibus omnibus desiderium assimilandi, non minus quam coëundi ad homogenea; verum ligatur ista virtus, sicut et illa, licet non iisdem modis. Sed modos illos, necnon solutionem ab iisdem, omni diligentia inquirere oportet, quia pertinent ad senectutis refocillationem[23]. Postremo videtur notatu dignum, quod in novem[24] illis motibus, de quibus diximus, corpora tantum naturae suae conservationem appetere videntur; in hoc decimo autem propagationem.

(12) Sit Motus Duodecimus, Motus *Excitationis*[25]; qui motus videtur esse ex genere *assimilationis*, atque eo nomine quandoque a nobis promiscue vocatur. Est enim motus diffusivus, et communicativus, et transitivus, et multiplicativus, sicut et ille; atque effectu (ut plurimum) consentiunt, licet efficiendi modo et subjecto differant. Motus enim *assimilationis* procedit tanquam cum imperio et potestate; jubet enim et cogit assimilatum in assimilantem verti et mutari. At motus *excitationis* procedit tanquam arte et insinuatione et furtim; et invitat tantum, et disponit excitatum ad naturam excitantis. Etiam motus *assimilationis* multiplicat et transformat corpora et substantias; veluti, plus fit flammae, plus

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[22] He means clay mixed up with pebbles or gravel, as in conglomerate strata. The induration would take place just as readily, if it were detached, provided it were subjected to the same influences in other respects.

[23] To attain this end is the practical object of the 'Historia Vitae et Mortis.' See also De Augmentis, lib. iv. cap. 2.

The word 'refocillatio,' which is not to be found in classical Latin, though the verb refocillo is occasionally found in post-Augustan writers, occurs in some of the old College graces, as, for instance, in that of Lincoln College, Oxford: 'Agimus Tibi gratias pro * * * praesentique refocillatione.'

[24] Nine, that is to say, excluding the first so-called 'motus,' which is common to all matter, and of which no examples are proposed; 'inest enim omni corpori.'

[25] The last 'motus' is conceived of as multiplying substances by assimilation, this as exciting or communicating qualities by means of diffusion. The growth of the body and its various parts would be the typical instance of the one, heat of the other.

aëris, plus spiritus, plus carnis. At in motu *excitationis*, multiplicantur et transeunt virtutes tantum; et plus fit calidi, plus magnetici, plus putridi[26]. Eminet autem iste motus praecipue in calido et frigido. Neque enim calor diffundit se in calefaciendo per communicationem primi caloris; sed tantum per *excitationem* partium corporis[27] ad motum illum qui est Forma Calidi; de quo in *vindemiatione prima de natura calidi* diximus. Itaque longe tardius et difficilius excitatur calor in lapide aut metallo quam in aëre[28], ob inhabilitatem et impromptitudinem corporum illorum ad motum illum; ita ut verisimile sit posse esse interius versus viscera terrae materias quae calefieri prorsus respuant; quia ob condensationem majorem spiritu illo destituuntur a quo motus iste *excitationis* plerunque incipit[29]. Similiter magnes induit ferrum nova partium dispositione et motu conformi; ipse autem nihil ex virtute perdit. Similiter fermentum panis, et flos cervisiae[30], et coagulum lactis, et nonnulla ex venenis,

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[26] On the doubtful character of this last example, see note 30 below.

[27] This view is, of course, the true one.

[28] This mistake, as already pointed out, arises from confusing the radiation with the conduction of heat.

[29] This curious passage seems to imply the notions that heat is communicated by means of a 'spiritus' and that, in very dense bodies, this 'spiritus' vanishes or is crushed out.

It is worth noting that Bacon regards the interior of the earth as much denser than the surface. Cp. Historia Densi et Rari, E. and S., vol. ii. pp. 248–9. 'De interioribus autem terrae nihil decernimus; cum nec sensui nec experimento subjiciantur. Illa, cum a calore coelestium primo longius, deinde penitus, semota sint, possint esse corporibus nobis notis densiora.' 'Cum fons densitatis videatur esse in profundo terrae, adeo ut versus superficiem ejus corpora eximie extenuentur; illud notatu dignum est, quod aurum,' &c. He then proceeds to ask why gold, which is so heavy, should be found on the surface of the earth.

[30] Yeast. 'The flower of beer.' For cervisia, see Pliny, lib. xxii. ad fin.

In consequence of the researches of Pasteur and others, the generally received opinion as to the working of yeast and leaven is that it is due to a chemical action set up by the life processes of minute organisms which have an indefinite power of self-multiplication. (See Watts' Dictionary of Chemistry, art. 'Fermentation,' both in vol. ii. and in the Supplement.) The opposed view, held by Liebig and others, attributing these changes entirely to chemical and physical forces, seems to have been set aside by recent experiments. Hence, these phenomena must be regarded as illustrating the last section rather than the present one. Putrefaction (see note 89 above) is a particular case of fermentation.

excitant et invitant motum in massa farinaria, aut cervisia, aut caseo, aut corpore humano, successivum et continuatum; non tam ex vi excitantis quam ex praedispositione et facili cessione excitati.

(13) Sit Motus Decimus Tertius, Motus *Impressionis*[31]; qui motus est etiam ex genere motus *assimilationis*, estque ex diffusivis motibus subtilissimus. Nobis autem visum est eum in speciem propriam constituere, propter differentiam insignem quam habet erga priores duos. Motus enim *assimilationis* simplex corpora ipsa transformat; ita ut si tollas primum movens nihil intersit ad ea quae sequuntur. Neque enim prima accensio in flammam, aut prima versio in aërem, aliquid facit ad flammam aut aërem in generatione succedentem. Similiter, motus *excitationis* omnino manet, remoto primo movente, ad tempora bene diuturna; ut in corpore calefacto, remoto primo calore; in ferro excito, remoto magnete; in massa farinaria, remoto fermento. At Motus *Impressionis*, licet sit diffusivus, et transitivus, tamen perpetuo pendere videtur ex primo movente; adeo ut, sublato aut cessante illo, statim deficiat et pereat; itaque etiam momento, aut saltem exiguo tempore[32], transigitur. Quare motus illos *assimilationis* et *excitationis*, motus *generationis Jovis*, quia generatio manet; hunc autem motum Motum *Generationis*

The coagulation of milk, when spontaneous, is also probably due to chemical action set up by minute living organisms. But, when produced by artificial means, as by an acid, the phenomenon is purely chemical, and may, therefore, be regarded as an example of the 'motus excitationis.'

As to poisons, we must distinguish three cases. Some poisons, like vaccine virus, are due to the indefinite self-multiplication of low organisms within the body. Others, like arsenic, act purely chemically. Lastly, a third class, like chloroform or prussic acid, act, as it were, physiologically, by destroying the dynamical activity of some tissue or organ. I am indebted for this division to Dr. Rolleston. The student will find some interesting remarks on the action of poisons in Dr. Carpenter's Human Physiology, 8th Ed., §§ 220–9 (ch. 7).

[31] This 'motus' is distinguished from the two last by the continuance of the original impressions being necessary to the continuance of the effects. Thus light or sound ceases, when the source of the impression is withdrawn.

[32] This qualification allows for the time required for the propagation of light or sound. Cp. Aph. 46, with notes upon it.

Saturni[33], quia natus statim devoratur et absorbetur, appellare consuevimus. Manifestat se vero hic motus in tribus; in lucis radiis; sonorum percussionibus; et magneticis, quatenus ad communicationem[34]. Etenim amota luce, statim pereunt colores et reliquae imagines ejus; amota percussione prima et quassatione corporis inde facta, paulo post perit sonus. Licet enim soni etiam in medio per ventos tanquam per undas[35] agitentur; tamen diligentius notandum est, quod sonus non tam diu durat quam fit resonatio[36]. Etenim impulsa campana, sonus ad bene magnum tempus continuari videtur; unde quis facile in errorem labatur, si existimet toto illo tempore sonum tanquam natare et haerere in aëre; quod falsissimum est. Etenim illa resonatio non est idem sonus numero, sed renovatur. Hoc autem manifestatur ex sedatione sive cohibitione corporis percussi. Si enim sistatur et detineatur campana fortiter et fiat immobilis, statim perit sonus nec resonat amplius; ut in chordis, si post primam percussionem tangatur chorda, vel digito ut in lyra, vel calamo ut in espinetis, statim desinit resonatio. Magnete autem remoto, statim ferrum decidit. Luna autem a mari non potest removeri; nec terra a ponderoso dum cadit[37]. Itaque de illis nullum fieri potest experimentum; sed ratio eadem est.

(14) Sit Motus Decimus Quartus, Motus *Configurationis*, aut *Situs*[38]; per quem corpora appetere videntur, non coi-

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[33] The Latin Saturnus was confounded with the Greek god Κρόνος. For the story, see Hesiod, Theogonia, l. 453, &c.

[34] That is, mere communication of motion, as distinguished from the magnetic induction spoken of above and in the last section. The latter is permanent; the former disappears with the attracting body.

[35] This looks as if Bacon had a vague notion of the undulatory motion of sound.

[36] He is speaking of the reinforcement of sound caused by the continued vibration of the object struck, even after the first effect of the percussion has ceased. The case of stringed instruments, which have sounding boards, is different from that of a bell. On the phenomena of Overtones and Resonance, see Tyndall on Sound or Helmholtz on Sensations of Tone.

[37] Note that here, as in ii. 45 and elsewhere, Bacon connects the fall of heavy bodies to the earth and the phenomena of the spring and neap tides with magnetic attraction.

[38] This 'motus' may be illustrated by the form of crystals, or the

tionem aut separationem aliquam, sed situm, et collocationem, et *configurationem* cum aliis. Est autem iste motus valde abstrusus, nec bene inquisitus. Atque in quibusdam videtur quasi incausabilis; licet revera (ut existimamus) non ita sit. Etenim si quaeratur cur potius coelum volvatur ab oriente in occidentem quam ab occidente in orientem[39]; aut cur vertatur circa polos positos juxta Ursas potius quam circa Orionem, aut ex alia aliqua parte coeli[40]: videtur ista quaestio tanquam quaedam extasis[41], cum ista potius ab experientia, et ut positiva[42] recipi debeant. At in natura profecto sunt quaedam

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cellular structure of animals and plants, or the tendency of each particular species to assume a definite shape. I cannot agree with Dr. Hippus that there is anything strange in referring to this head the directions of the celestial motions or the polarity of the magnetic needle.

[39] Or, as we should put it, why the earth rotates from west to east. This direction of motion, whether orbital or axial, as we have already seen (see ii. 36 (2) with note 92), is common to all the planets and their satellites, with the sole known exception of the satellites of Uranus. Moreover, the sun itself rotates on its axis in the same direction. For Laplace's calculations, by which he showed the enormously preponderating probability of some common cause for this uniformity of direction, see Jevons' Principles of Science, vol. i. pp. 287–9, and the works, on both sides of the question, there referred to. This cause is, in all probability, connected with the circumstances of the detachment of the planets or satellites from the central mass of which they are supposed, according to the nebular hypothesis, to have originally formed a part. For this ingenious theory and for the earlier one of Buffon, which had for its object the explanation of the same phenomena, see Laplace, Exposition du Système du Monde, note vii. (Œuvres, vol. vi. p. 470, &c.).

[40] Mr. Ellis, commenting on the corresponding passage below, says: 'This passage shows that Bacon was not aware that the poles are not fixed (collocati) anywhere; in other words, that he was not acquainted with the precession of the equinoxes;—an additional proof how little of his attention had been given to mathematical physics.' In the Historia Ventorum (E. and S., vol. ii. p. 28), as Mr. Spedding has pointed out, he speaks of the north pole as being above, and the south pole below us. See Mr. Spedding's Preface to the De Interpretatione Naturae Prooemium, vol. iii. p. 512.

[41] ἔκστασις, a displacement, or a standing aside. We may construe 'out of place.' The word is common in Aristotle.

[42] 'As ultimate facts.' Cp. i. 48, with note 73. However far we may carry our speculations, there is always something beyond which is left unexplained. And this the human mind, with its restless activity, attempts, and cannot but attempt, to resolve. There must always, it is true,

ultima et incausabilia; verum hoc[43] ex illis non esse videtur. Etenim hoc fieri existimamus ex quadam harmonia et consensu mundi, qui adhuc non venit in observationem. Quod si recipiatur motus terrae ab occidente in orientem, eaedem manent quaestiones. Nam et ipsa super aliquos polos movetur. Atque cur tandem debeant isti poli collocari magis ubi sunt quam alibi? Item verticitas, et directio, et declinatio magnetis ad hunc motum referuntur. Etiam inveniuntur in corporibus tam naturalibus quam artificialibus, praesertim consistentibus et non fluidis, collatio quaedam et positura partium, et tanquam villi et fibrae, quae diligenter investigandae sunt; utpote sine quarum inventione corpora illa commode tractari aut regi non possunt. At circulationes illas in liquidis, per quas illa dum pressa sint, antequam se liberare possunt, se invicem relevant, ut compressionem illam ex aequo tolerent, motui *libertatis* verius assignamus.

(15) Sit Motus Decimus Quintus, Motus *Pertransitionis*, sive Motus *secundum Meatus;* per quem virtutes corporum magis aut minus impediuntur aut provehuntur a mediis ipsorum, pro natura corporum et virtutum operantium, atque etiam medii. Aliud enim medium[44] luci convenit, aliud sono,

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be some barrier to these efforts, but, unless they were constantly being made, the mind would become atrophied, and human knowledge would soon be at a standstill.

[43] This remark does credit to Bacon's sagacity. See note 39 above, on Laplace's nebular hypothesis. Though, of course, Bacon had not the slightest suspicion of such explanations as would now be given, still he had the penetration to suspect that there must be some explanation forthcoming.

[44] On the medium of Light, cp. Topica Inquisitionis De Luce et Lumine, x, xi (E. and S., vol. ii. p. 320), and Sylva Sylvarum, Exps. 761–2, where he notices the phenomenon of Refraction; on the medium of Sound, the numerous 'Experiments' on Sound in Sylva Sylvarum, Centuries ii, iii; on the medium of Heat, the numerous remarks scattered throughout this Book of the Novum Organum; and on the medium through which the Magnet acts, the Inquisitio De Magnete (E. and S., vol. ii. pp. 311–2), and Nov. Org. ii. 42. His remarks on the transmission of Heat are vitiated throughout by his not distinguishing between radiation and conduction.

One of the most important differences with respect to transmission through media is that, while heat and light can be transmitted in vacuo, sound cannot. Moreover, the denser the air in which a sound is generated, the more intense is it. There is some doubt about electricity, but

aliud calori et frigori, aliud virtutibus magneticis, necnon aliis nonnullis respective.

(16) Sit Motus Decimus Sextus, Motus *Regius* (ita enim eum appellamus) sive *Politicus*[45]; per quem partes in corpore aliquo praedominantes et imperantes reliquas partes fraenant, domant, subigunt, ordinant, et cogunt eas adunari, separari, consistere, moveri, collocari, non ex desideriis suis, sed prout in ordine sit et conducat ad bene esse partis illius imperantis; adeo ut sit quasi *Regimen* et *Politia* quaedam, quam exercet pars regens in partes subditas. Eminet autem hic motus praecipue in spiritibus animalium, qui motus omnes partium reliquarum, quamdiu ipse in vigore est, contemperat. Invenitur autem in aliis corporibus in gradu quodam inferiore; quemadmodum dictum est de sanguine et urinis, quae non solvuntur donec spiritus, qui partes earum commiscebat et cohibebat, emissus fuerit aut suffocatus. Neque iste motus omnino spiritibus proprius est, licet in plerisque corporibus spiritus dominentur ob motum celerem et penetrationem. Veruntamen in corporibus magis condensatis, nec spiritu vivido et vigente (qualis inest argento vivo et vitriolo) repletis, dominantur potius partes crassiores; adeo ut nisi fraenum et jugum hoc arte aliqua excutiatur, de nova aliqua hujusmodi corporum transformatione minime sperandum sit. Neque vero quispiam nos oblitos esse existimet ejus quod nunc agitur; quia cum ista series et distributio motuum ad nil aliud spectet, quam ut illorum *praedominantia* per *instantias luctae* melius inquiratur, jam inter motus ipsos *praedomi-*

'Gassiot has proved that in a vacuum produced by chemical means, which is the most perfect attainable, an electrical discharge does not pass: and at present it is considered that a ponderable medium is necessary for the propagation of electricity.' Ganot's Physics, § 698. A magnet will act in vacuo, but Faraday has shewn that a substance, which is paramagnetic in vacuo, may become diamagnetic in air.

[45] This somewhat fanciful notion, still more fancifully illustrated, requires no comment. Better illustrations would have been, in respect of determining functions, the place of the heart and brain in the animal economy, or, in respect of relative importance, that of the seed-vessels in plants. For the metaphor, cp. Arist. Pol. i. 5 (6): *ἡ μὲν γὰρ ψυχὴ τοῦ σώματος ἄρχει δεσποτικὴν ἀρχήν, ὁ δὲ νοῦς τῆς ὀρέξεως πολιτικὴν καὶ βασιλικήν, κ. τ. λ.*

nantiae mentionem faciamus. Non enim in descriptione *motus* istius *regii*, de *praedominantia* motuum aut virtutum tractamus, sed de *praedominantia* partium in corporibus. Haec enim ea est *praedominantia*, quae speciem istam motus peculiarem constituit.

(17) Sit Motus Decimus Septimus, Motus *Rotationis Spontaneus*[46]; per quem corpora motu gaudentia, et bene collocata, natura sua fruuntur, atque seipsa sequuntur, non aliud, et tanquam proprios petunt amplexus. Etenim videntur corpora aut movere sine termino; aut plane quiescere; aut ferri ad terminum, ubi pro natura sua aut rotent aut quiescant. Atque quae bene collocata sunt, si motu gaudeant, movent per circulum: motu scilicet aeterno et infinito. Quae bene collocata sunt, et motum exhorrent, prorsus quiescunt. Quae non bene collocata sunt, movent in linea recta (tanquam tramite brevissimo) ad consortia suorum connaturalium[47]. Recipit autem motus iste *rotationis* differentias novem[48]. Primam, centri sui, circa quod corpora movent: secundam, polorum suorum, supra quos movent: tertiam, circumferentiae

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[46] Cp. ii. 5 ad fin., ii. 35, ii. 36 (2), and notes. There is little on this subject to add to what has already been said on the above passages. The reader will not fail to contrast Bacon's curious conceptions about motion (derived from the Peripatetics) with the Laws of Motion, as known to us.

[47] 'This passage is wholly in accordance with the Peripatetic system of physics. But the modifications which Bacon goes on to enumerate, to which, as he conceives, the eternal circular motions of the heavenly bodies may be subject, are sufficient to destroy the whole *à priori* argument in favour of such a system of astronomy as that which we find in the twelfth book of the Metaphysics. It has not been sufficiently observed that the Ptolemaic system is no less at variance with the Peripatetic philosophy than the heliocentrical. The attempts of Turrianus and Fracastorius to construct what may be called an orthodox system of astronomy—that is one in which all the motions should take place in circles of which the earth is the centre—was suggested chiefly, as we learn from the Homocentrica of the latter, by the wish to reconcile astronomy and philosophy. It had no scientific value, since it left all the phenomena of variations of parallax and apparent diameter unexplained, or, at any rate, gave an explanation of them which no astronomer would accept. It was nevertheless favourably received by the systematic Peripaticians. See, for instance, Flaminius, De prima Philosoph. Paraph. p. 119. (I quote the Basle edition of 1557.)' Mr. Ellis' note.

[48] That is, nine respects in which the motions may differ.

sive ambitus sui, prout distant a centro: quartam, incitationis suae, prout celerius aut tardius rotant: quintam, consequutionis motus sui, veluti ab oriente in occidentem, aut ab occidente in orientem: sextam, declinationis a circulo perfecto per spiras longius aut propius distantes a centro suo: septimam, declinationis a circulo perfecto per spiras longius aut propius distantes a polis suis: octavam, distantiae propioris aut longioris spirarum suarum ad invicem: nonam et ultimam, variationis ipsorum polorum [49], si sint mobiles: quae ipsa ad rotationem non pertinet, nisi fiat circulariter [50]. Atque iste motus communi et inveterata opinione habetur pro proprio coelestium. Attamen gravis de illo motu lis est inter nonnullos tam ex antiquis quam modernis, qui *rotationem* terrae attribuerunt. At multo fortasse justior [51] movetur controversia (si modo res non sit omnino extra controversiam), an motus videlicet iste (concesso quod terra stet) coeli finibus contineatur, an potius descendat, et communicetur aëri et aquis [52]. Motum autem *rotationis* in missilibus, ut in spiculis, sagittis, pilis sclopetorum, et similibus, omnino ad motum *libertatis* rejicimus [53].

(18) Sit Motus Decimus Octavus, Motus *Trepidationis*, cui (ut ab astronomis intelligitur) non multum fidei adhibemus [54].

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[49] That is, libration.

The reader need hardly be again reminded that he will find a detailed account of Bacon's astronomical views (written, however, about eight years before the publication of the Novum Organum), in the Descriptio Globi Intellectualis and the appended tract Thema Coeli (E. and S., vol. iii. pp. 713–80).

[50] Mr. Ellis says: 'I believe the sense is that unless we restrict ourselves to circular motion, that is, unless we reject the sixth and seventh species of variation, it will not be necessary for us to suppose the poles themselves to be movable: in other words, that the phenomena of which we could by this hypothesis give an account may be adequately represented without it by means of spirals.'

[51] This language, the reader will perceive, exactly accords with what we have so often elsewhere found to be Bacon's opinion not only as to the annual, but also as to the diurnal motion of the earth.

[52] Cp. Aph. 36 (2), and notes.

[53] See 'Motus tertius' above, and Aph. 36 (6).

[54] 'The name of trepidation was given by the Alphonsine astronomers to a motion by which they imagined the starry heaven to be affected, and

Nobis autem corporum naturalium appetitus ubique serio perscrutantibus occurrit iste motus; et constitui debere videtur in speciem. Est autem hic motus veluti aeternae cujusdam captivitatis. Videlicet ubi corpora non omnino pro natura sua bene locata, et tamen non prorsus male se habentia, perpetuo trepidant, et irrequiete se agant, nec statu suo contenta, nec ulterius ausa progredi. Talis invenitur motus in corde et pulsibus animalium; et necesse est ut sit in omnibus corporibus, quae statu ancipiti ita degunt inter commoda et incommoda, ut distracta liberare se tentent, et denuo repulsam patiantur, et tamen perpetuo experiantur [55].

(19) Sit Motus Decimus Nonus et postremus, motus ille cui vix nomen motus competit, et tamen est plane motus. Quem motum, Motum *Decubitus* [56], sive Motum *Exhorrentiae Motus*,

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in virtue of which its equinoxes described small circles of nine degrees radius about those of the ninth or next superior orb. To account for this motion they introduced a tenth orb. The phenomenon, however, thus accounted for was altogether imaginary, although it is true that the length of the tropical year, by supposed variations of which the idea of trepidation was suggested, is not rigorously constant. It may be questioned whether Bacon's hesitation to accept the astronomical motion of trepidation had any better foundation than his doubts whether the proper motions of the planetary orbs were anything more than "res confictae et suppositae." [See Aph. 36 (2).] The question of the existence or non-existence of trepidation could only be decided by a person conversant with the details of the received system of astronomy.' Mr. Ellis' note.

[55] Cp. Historia Densi et Rari, E. and S., vol. ii. p. 263: 'Pulsus cordis et arteriarum in animalibus fit per irrequietam dilatationem spirituum, et receptum ipsorum, per vices.' In reading vague and fanciful passages like these, we must recollect that Harvey did not begin to teach his theory of the circulation of the blood till 1619, and that it was not till 1628 that his great treatise, the 'Exercitatio Anatomica de Motu Cordis et Sanguinis in Animalibus' was published. Bacon might, it is true, have derived more precise views than those which he expresses from earlier writers, but there was nothing specially to direct his attention to this subject.

The Tides and the astronomical phenomena of Nutation and Libration might furnish appropriate instances of the 'Motus Trepidationis.'

[56] Decubitus = lying away from, sc. motion. See Facciolati on decubo. He quotes Fabius Pictor apud Aul. Gell. lib. x. cap. 15: 'Pedes lecti, in quo cubat [sc. Flamen Dialis], luto tenui circumlitos esse oportet: et de eo lecto trinoctium continuum non decubat: neque in eo lecto cubare alium fas est.' Decubitus might, however, simply mean 'lying down,' 'reclining,' 'repose.' (Cp. decumbo.)

vocare licet. Per hunc motum terra stat mole sua[57], moventibus se extremis suis in medium; non ad centrum imaginativum, sed ad unionem. Per hunc etiam appetitum omnia majorem in modum condensata motum exhorrent, atque illis pro omni appetitu est non moveri; et licet infinitis modis vellicentur et provocentur ad motum, tamen naturam suam (quoad possunt) tuentur. Quod si ad motum compellantur, tamen hoc agere semper videntur ut quietem et statum suum recuperent, neque amplius moveant. Atque circa hoc certe se agilia praebent, et satis perniciter et rapide (ut pertaesa et impatientia omnis morae) contendunt. Hujus autem appetitus imago ex parte tantum cerni potest; quia hic apud nos, ex subactione et concoctione coelestium[58], omne tangibile non tantum non condensatum est ad ultimitatem, sed etiam cum spiritu nonnullo miscetur.

Proposuimus itaque jam species sive elementa simplicia motuum, appetituum, et virtutum activarum, quae sunt in

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On Bacon's vague and improper use of the word 'motion,' see the first note on this Aphorism. Here it cannot be rendered even by 'process' or 'operation,' but we must resort to some word of very wide meaning, such as 'tendency' or 'affection' of matter.

'Inertia,' the property of which Bacon here speaks, is simply the incapacity of matter to change its own state of rest or motion. The obscure notions of Bacon aud his contemporaries about motion prevented them from seeing that this property applies as much to the tendency of a body in motion to go on moving as to that of a body at rest to remain at rest. For a brief account of the establishment of the First Law of motion (which seems to have been first enunciated by Galileo in 1638), see Whewell's History of the Inductive Sciences, vol. ii. bk. vi. ch. 2.

[57] Bacon seems never weary of parading his belief in the immobility of the earth.

[58] Cp. what he says above under 'Motus Duodecimus:' 'ita ut verisimile sit posse esse,' &c. It was one of the leading doctrines of Telesius that the sun, and the heavenly bodies generally, modify the surface of the earth and the parts adjacent to the surface, rendering them rarer and warmer than they are by their own nature; while the interior parts of the earth exhibit its peculiar characteristics of coldness, crassness, darkness, and immobility. See Telesius, De Rerum Natura, lib. i. (especially chs. 5, 10–14); Bacon, De Principiis atque Originibus, E. and S., vol. iii. pp. 98–9.

Towards the end of Aph. 20, Bacon uses the expression 'imbutum a coelestibus,' on which see note.

natura maxime catholica. Neque parum scientiae naturalis sub illis adumbratum est. Non negamus tamen et alias species fortasse addi posse[59], atque istas ipsas divisiones secundum veriores rerum venas transferri, denique in minorem numerum posse redigi. Neque tamen hoc de divisionibus aliquibus abstractis intelligimus: veluti si quis dicat corpora appetere vel conservationem, vel exaltationem, vel propagationem, vel fruitionem naturae suae; aut si quis dicat motus rerum tendere ad conservationem et bonum, vel universi, ut *antitypiam* et *nexum;* vel universitatum magnarum, ut motus *congregationis majoris, rotationis,* et *exhorrentiae motus;* vel formarum specialium, ut reliquos. Licet enim haec vera sint, tamen nisi terminentur[60] in materia et fabrica secundum veras lineas, speculativa sunt, et minus utilia. Interim sufficient et boni erunt usus ad pensitandas *praedominantias* virtutum et exquirendas *instantias luctae;* id quod nunc agitur.

Etenim ex his quos proposuimus motibus alii prorsus sunt invincibiles; alii aliis sunt fortiores, et illos ligant, fraenant, disponunt; alii aliis longius jaculantur; alii alios tempore et celeritate praevertunt; alii alios fovent, roborant, ampliant, accelerant.

Motus *antitypiae* omnino est adamantinus et invincibilis. Utrum vero Motus *nexus* sit invincibilis adhuc haeremus. Neque enim pro certo affirmaverimus[61] utrum detur Vacuum,

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[59] Dr. Hippus remarks very well that this class of facts or rather tendencies might have been further illustrated by *torsion* or the effort made by a thread, wire, or the like, when twisted, to untwist itself.

To attempt to classify, reduce, or complete this list of so-called 'motions,' would be of no service to the student. I have already said enough to enable him to estimate the value of Bacon's enumeration, as well as its various errors and defects.

[60] Be 'defined,' or 'limited.'

[61] In ii. 8, Bacon absolutely denies the existence of a vacuum. See note on that passage and also note 51 on the 'Motus Secundus.' In the latter note, I have referred to Bacon's change of opinion on the subject of a vacuum, and have quoted a 'Canon' from the Historia Densi et Rari (which work, or, at least, the latter part of it, was written during his last 'quinquennium'), where he says: 'Non est vacuum in natura, nec congregatum nec intermistum.' See E. and S., vol. ii. p. 303. Taking that as his last utterance on the subject, and bearing in mind the positive manner in which he speaks in ii. 8, as also the apparent bias of i. 66 and

sive coacervatum sive permistum [62]. At de illo nobis constat, rationem illam [63], propter quam introductum est Vacuum a Leucippo et Democrito (videlicet quod absque eo non possent eadem corpora complecti et implere majora et minora spatia), falsam esse. Est enim plane *plica materiae* [64] complicantis et replicantis se per spatia, inter certos fines, absque interpositione vacui; neque est in aëre ex vacuo bis millies (tantum enim esse oportet) plus quam in auro [65]. Id quod ex

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ii. 48 (2), we must, I think, notwithstanding the expressions of doubt in the present passage, regard him as having deliberately rejected the doctrine of a vacuum.

[62] I borrow the following note from Ellis and Spedding's Edition: '"Vacuum permistum," κενὸν ἀχώριστον, is vacuum diffused through the interstices of any portion of matter. By "vacuum coacervatum," κενὸν κεχωρισμένον, is meant clear empty space. See, for this distinction, Aristotle, Phys. iv. 7 [p. 214]. Hero of Alexandria, whom Bacon mentions more than once, approves of those who admit the former kind of vacuum and reject the latter. See the Introduction to his Spiritalia.

'[It is perhaps worth observing that in the fable entitled "Cupido sive Atomus" (De Sap. Vet. xvii), where the theory of a vacuum is mentioned, this distinction was not introduced till Bacon revised the work in his later years. The passage which stands thus in the original edition (1609)—"Quisquis autem atomum ponit et vacuum, necessario virtutem atomi ad distans introducit"—is altered, in the edition published by Rawley after Bacon's death, to "Quisquis autem atomum asserit atque vacuum (licet istud vacuum intermistum ponat, non segregatum) necessario," &c.—*J. S.*]'

Cp. the similar distinction of 'aer permistus' and 'aer coacervatus' in Aph. 50 ad init.

[63] For this and other reasons, see Arist. Phys. iv. 6 (p. 213 b).

[64] Cp. Historia Densi et Rari, E. and S., vol. ii. p. 303: 'Inter terminos densi et rari est plica materiae, per quam se complicat et replicat absque vacuo.'

Plica (from plico) is explained by Du Cange as 'plicatura vel involutio.'

[65] 'Nor is there in air two thousand times more of vacuity than in gold.' In ii. 40, he states the density of gold at 21 times that of spirits of wine, and that of spirits of wine at 100 times that of its own vapour; while in the Historia Densi et Rari (E. and S., vol. ii. p. 255), he says that all fumes are rarer than air. This would make the density of gold more than 2100 times greater than that of air, or, speaking roughly, 2000 times greater. Bacon, who was not much of a mathematician, probably took for granted that the ratio of the amounts of vacuity, contained in equal weights of the two bodies, was inversely that of the densities. But this is plainly not the case.

Proceeding on a calculation based on passages in the Historia Densi et Rari only, Mr. Ellis makes the supposed density of gold 1900-fold that

potentissimis corporum pneumaticorum virtutibus (quae aliter tanquam pulveres minuti natarent in vacuo), et multis aliis demonstrationibus, nobis satis liquet. Reliqui vero Motus regunt et reguntur invicem, pro rationibus vigoris, quanti, incitationis, ejaculationis, necnon tum auxiliorum tum impedimentorum quae occurrunt.

Exempli gratia: magnes armatus nonnullus detinet et suspendit ferrum, ad sexagecuplum pondus ipsius; eo usque dominatur motus *congregationis minoris* super motum *congregationis majoris;* quod si majus fuerit pondus, succumbit. Vectis tanti roboris sublevabit tantum pondus; eo usque dominatur motus *libertatis* super motum *congregationis majoris;* sin majus fuerit pondus, succumbit. Corium tensum ad tensuram talem non rumpitur; eo usque dominatur motus *continuationis* super motum *tensurae;* quod si ulterior fuerit tensura, rumpitur corium, et succumbit motus *continuationis.* Aqua per rimam perforationis talis effluit; eo usque dominatur motus *congregationis majoris* super motum *continuationis;* quod si minor fuerit rima, succumbit, et vincit motus *continuationis.* In pulvere sulphuris solius immissi[66] in sclopetum cum pila, et admoto igne, non emittitur pila; in eo motus *congregationis majoris* vincit motum *hyles.* At in pulvere pyrio immisso vincit motus *hyles* in sulphure, adjutus motibus *hyles* et *fugae* in nitro. Et sic de caeteris. Etenim *instantiae luctae* (quae indicant *praedominantiam* virtutum, et secundum quas rationes et calculos praedominentur et succumbant) acri et sedula diligentia undique sunt conquirendae.

Etiam modi et rationes ipsius succumbentiae motuum diligenter sunt introspiciendae. Nempe, an omnino cessent, vel potius usque nitantur, sed ligentur. Etenim in corporibus hic apud nos, nulla vera est quies, nec in integris nec in partibus; sed tantum secundum apparentiam[67]. Quies autem

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of air. Supposing that nineteen-twentieths of the gold consisted of vacuity (perhaps not an extravagant calculation, when we consider the supposed density of the bodies in the interior of the earth), the ratio of vacuity in the same weights of air and gold would $= 1899 + \frac{19}{20} : \frac{19}{20} =$ (approximately) $\frac{1900 \times 20}{20} : \frac{19}{20} = 2000 : 1$, the ratio given in the text.

[66] Mr. Ellis proposes to read 'immisso.'

[67] See note 58 above. The 'hic apud nos' is opposed to the interior

ista apparens causatur aut per *aequilibrium*, aut per absolutam *praedominantiam* motuum. Per *aequilibrium*, ut in bilancibus, quae stant si aequa sint pondera. Per *praedominantiam*, ut in hydriis perforatis, ubi quiescit aqua et detinetur a decasu [68], per *praedominantiam* motus *nexus*. Notandum tamen est (ut diximus) quatenus nitantur motus illi succumbentes. Etenim si quis per luctam detineatur extensus in terra, brachiis et tibiis vinctis, aut aliter detentis; atque ille tamen totis viribus resurgere nitatur; non est minor nixus, licet non proficiat [69]. Hujus autem rei conditio (scilicet utrum per *praedominantiam* motus succumbens quasi annihiletur, an potius continuetur nixus, licet non conspiciatur), quae latet in conflictibus, apparebit fortasse in concurrentiis. Exempli gratia; fiat experimentum in sclopetis, utrum sclopetus, pro tanto spatio quo emittat pilam in linea directa, sive (ut vulgo loquuntur) in puncto blanco, debiliorem edat percussionem ejaculando in supra, ubi Motus Ictus est simplex, quam desuper, ubi Motus Gravitatis concurrit cum Ictu [70].

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parts of the earth. The equilibrium of entire bodies, he supposes, is only apparent, while, amongst the ultimate particles of bodies, there is a motion constantly going on,—a 'latens processus,' a 'latio per minima.'

This idea, I need hardly say, is in accordance with the views of the most recent physicists, who regard the minute molecules of which matter is or may be supposed to be composed as being in a constant state of motion. See, for instance, Tyndall's Heat a Mode of Motion, ch. 3 with the Appendix. M. Bouillet points out the coincidence between Bacon's opinion and that of Leibnitz, as shewn, amongst other places, in the following passage: 'Et hanc agendi virtutem omni substantiae inesse aio, semperque aliquam ex eo actionem nasci; adeoque nec ipsam substantiam corpoream (non magis quam spiritualem) ab agendo cessare unquam; quod illi non satis percepisse videntur, qui essentiam ejus in sola extensione, vel etiam impenetrabilitate collocaverunt, et corpus omnimode quiescens concipere sibi sunt visi.' De Primae Philosophiae Emendatione, Acta Eruditorum, 1694. Ed. Erdmann, p. 122.

[68] In 'Motus Secundus,' he adds the important words 'nisi os hydriae ad immittendum aerem aperiatur.' These phenomena, when once observed, ought to have led to the discovery of the pressure of the atmosphere.

[69] This is, of course, true. A cause always operates to the full extent of its efficiency, though its effects may not be apparent, owing to the action of other causes, whether concurring or counteracting. Though a truism, when once stated, this consideration is often lost sight of.

[70] This passage is very curious, as shewing that Bacon had no suspicion

Etiam canones *praedominantiarum* qui occurrunt colligendi sunt. Veluti, quod quo communius est bonum quod appetitur, eo motus est fortior[71] ut motus *nexus*, qui respicit communionem universi, fortior est motu gravitatis, qui respicit communionem densorum. Etiam quod appetitus qui sunt boni privati, non praevalent plerunque contra appetitus boni magis publici, nisi in parvis quantis. Quae utinam obtinerent in civilibus.

XLIX.

Inter *praerogativas instantiarum* ponemus loco vicesimo quinto *Instantias Innuentes*[72]; eas scilicet, quae commoda ho-

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that, in both cases alike, the force of gravity is acting at every moment of the projectile's path; nor was he aware, of course, that the path of the projectile, if we leave out of account the resistance of the atmosphere, is in all cases a parabola. The experiment proposed is to ascertain how far a gun will carry point-blank, and then, firing that distance, first upwards, then downwards, to compare the force of the two shots. As the velocity at any point of the parabola is that which would be acquired in falling from the directrix, there can be no doubt that the downward shot would make much the greater impression of the two. But, as it is almost needless to add, Bacon entirely mistook the conditions of the problem.

The true theory of the motion of projectiles was first distinctly enunciated by Galileo in the fourth of his Dialogues on Motion, which were published at Leyden in 1638 (Dialoghi delle Nuove Scienze, Giornata iv, Florence Ed., vol. xiii. p. 222, &c.). On the previous speculations of Tartalea, Digges, &c., see Whewell's History of the Inductive Sciences, vol. ii. bk. vi. ch. 2. sect. 3, and Drinkwater's Life of Galileo (Lib. Soc. U. K.), ch. 16. It is curious that one of the books (the Pantometria, published in 1591), in which Thomas Digges alludes to the compounded motion of a projectile, was dedicated to Sir Nicholas Bacon, Bacon's father. A series of very interesting remarks on this subject will be found at the end of the Stratioticos, published by Digges in 1579.

[71] Note this strange application of the doctrine of Final Causes, and the very doubtful example by which it is supported.

On Public and Private Good, cp. the interesting passages in De Augm. vii. 1 (E. and S., vol. i. p. 717, &c.), or Advancement of Learning, bk. ii. (E. and S., vol. iii. p. 420, &c.). The application of this distinction to 'judge and determine the controversies wherein Moral Philosophy is conversant' has a peculiar interest in reference to subsequent ethical speculation.

[72] These are the first of the three 'Instantiae propitiae sive benevolae' (see Aph. 44). Their office is 'dirigere operativam ad ea quae maxime hominum intersunt.' Hence, they are called 'Intimating Instances;' for

minum innuunt aut designant. Etenim ipsum *Posse* et ipsum *Scire* naturam humanam amplificant, non beant[73]. Itaque decerpenda sunt ex universitate rerum ea quae ad usus vitae maxime faciunt. Verum de iis erit magis proprius dicendi locus, cum *Deductiones ad Praxim*[74] tractabimus. Quinetiam in ipso opere Interpretationis circa singula subjecta, locum semper *Chartae Humanae*, sive *Chartae Optativae*[75], assignamus. Etenim et quaerere et optare non inepte, pars scientiae est[76].

L.

Inter *praerogativas instantiarum* ponemus loco vicesimo sexto *Instantias Polychrestas*[77]. Eae sunt, quae pertinent ad varia et saepius occurrunt; ideoque operae et novis probationibus haud parum parcunt. Atque de instrumentis ipsis atque ingeniationibus[78] proprius erit dicendi locus, cum Deductiones ad Praxim et Experimentandi Modos tractabimus. Quinetiam quae adhuc cognita sunt et in usum venerunt, in Historiis Particularibus singularum artium describentur[79]. In

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they suggest to us what are profitable, and what are unprofitable directions for our experiments, energies, or speculations.

[73] On the necessity of the union of Knowledge and Practice, Science and Art, see i. 81, ii. 4, and the various other passages on the same subject which abound in this treatise. In i. 3, the lesson is conveyed in a somewhat different form: 'Scientia et potentia humana in idem coincidunt.'

[74] See ii. 21.

[75] Cp. the Tables, bearing these names, at the end of the Historia Ventorum and Historia Densi et Rari.

[76] As Mr. Kitchin observes, this maxim is but another form of the famous dictum, 'Prudens quaestio est dimidium scientiae.'

[77] Cp. De Gen. Anim. v. 8 ad fin. (p. 789 b. 9–12): *οἷον γὰρ ἔνια πολύχρηστά ἐστι τῶν περὶ τὰς τέχνας, ὥσπερ ἐν τῇ χαλκευτικῇ ἡ σφύρα καὶ ὁ ἄκμων, οὕτως καὶ τὸ πνεῦμα ἐν τοῖς φύσει συνεστῶσιν.* Galen (Ed. Kühn, tom. xiii. pp. 501, 763) speaks of *φάρμακα πολύχρηστα.* This is the class of instances 'quae parcunt instrumentis' (see Aph. 44), and includes all rules, processes, or instruments, which, being applicable to a great variety of cases, shorten or facilitate our observations and experiments. They cannot be accurately discriminated from the Instantiae Radii and the Instantiae Curriculi.

[78] 'Ingenious contrivances.' The word does not occur in classical Latin, though ingeniatus is found in Plautus and other writers. Ducange has the verb ingeniare.

[79] See the Catalogus Historiarum Particularium, which was published at the end of the First Edition of the Novum Organum. Bacon tells us, at

praesenti autem subjungemus quaedam catholica circa ea pro exemplis tantum *polychresti*.

Operatur igitur homo super corpora naturalia (praeter ipsam admotionem et amotionem[80] corporum simplicem) septem praecipue modis: nempe, vel per exclusionem eorum quae impediunt et disturbant; vel per compressiones, extensiones, agitationes, et hujusmodi; vel per calorem et frigus; vel per moram in loco convenienti; vel per fraenum et regimen motus; vel per consensus speciales; vel per alternationem tempestivam et debitam, atque seriem et successionem horum omnium; aut saltem nonnullorum ex illis.

(1) Ad primum igitur quod attinet; aër communis qui undique praesto est et se ingerit, atque radii coelestium, multum turbant. Quae itaque ad illorum exclusionem[81] faciunt, merito haberi possint pro *polychrestis*. Huc igitur pertinent materies et crassities vasorum, in quibus corpora ad operationem praeparata reponuntur. Similiter, modi accurati obturationis vasorum, per consolidationem et *lutum sapientiae*[82], ut loquuntur chymici. Etiam clausura per liquores in extimis, utilissima res est; ut cum infundunt oleum super vinum aut succos herbarum, quod expandendo se in summitate instar operculi, optime ea conservat illaesa ab aëre. Neque pulveres res malae sunt; qui, licet contineant aërem permistum[83], tamen vim aëris coacervati et circum-

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the end of the Parasceve, that it was his design, as soon as he was at leisure, 'in singulis veluti interrogando docere, qualia sint circa unamquamque historiarum illarum potissimum inquirenda et conscribenda.'

[80] Cp. i. 4.

[81] The Air-Pump, invented about 1654 by Otto von Guericke of Magdeburg and subsequently so much improved by Boyle, would have exactly met Bacon's requirements, so far as air is concerned. Light is excluded with comparative ease.

[82] *Lutum sapientiae* or *philosophorum* was a composition, employed for the purpose of sealing hermetically the orifices of vessels. Pliny (Nat. Hist. xxix. 3 (11), sect. 51) gives a short recipe for piecing together broken fragments of glass: 'Et, ne quid desit ovorum gratiae, candidum ex his admixtum calci vivae glutinat vitri fragmenta.' Albertus Magnus (referred to by Hoefer, Histoire de la Chimie, tome i. p. 388) enumerates different kinds of 'lutes,' varying their composition according to the difference of temperature.

[83] Here we have the same distinction as that between the 'vacuum

fusi arcent: ut fit in conservatione uvarum et fructuum intra arenam, et farinam. Etiam cera, mel, pix, et hujusmodi tenacia, recte obducuntur ad clausuram perfectiorem, et ad summovendum aërem et coelestia. Etiam nos experimentum quandoque fecimus, ponendo vas, necnon aliqua alia corpora, intra argentum vivum, quod omnium longe densissimum est ex iis quae circumfundi possunt. Quinetiam specus et cavernae subterraneae magni usus sunt ad prohibendum insolationem[84] et aërem istum apertum praedatorium; qualibus utuntur Germani Septentrionales pro granariis. Necnon repositio corporum in fundo aquarum ad hoc spectat: ut memini me quippiam audisse de utribus vini demissis in profundum puteum, ad infrigidationem scilicet, sed casu et per neglectum ac oblivionem ibidem remanentibus per multos annos, et deinde extractis; unde vinum factum est non solum non vapidum aut emortuum, sed multo magis nobile ad gustum, per commixtionem partium suarum (ut videtur) magis exquisitam. Quod si postulet res ut corpora demittantur ad fundum aquarum, veluti intra fluvios aut mare, neque tamen aquas tangant, nec in vasibus obturatis concludantur, sed aëre tantum circumdentur; bonus est usus vasis illius quod adhibitum est nonnunquam ad operandum subter aquis super navigia demersa, ut urinatores diutius manere possint sub aquis, et per vices ad tempus respirare. Illud hujusmodi erat. Conficiebatur dolium ex metallo concavum, quod demittebatur aequabiliter ad superficiem aquae, atque sic deportabat totum aërem qui continebatur in dolio secum in fundum maris. Stabat autem super pedes tres (instar tripodis), qui longitudinis erant aliquanto minoris statura hominis; ita ut urinator posset cum anhelitus deficeret, immittere caput in cavum dolii, et respirare, et deinde opus continuare[85].

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permistum' and the 'vacuum coacervatum' in the concluding remarks of ii. 48. In the present passage, the meaning is obvious.

[84] Drying in the sun, or exposure to the sun. The word is used by Pliny, Nat. Hist. xxi. 14 (49), sect. 84.

[85] Cp. Historia Densi et Rari, E. and S., vol. ii. p. 299. Beckmann (History of Inventions) has a long article on the history of Diving and Diving-Bells. 'The oldest information,' he says, 'that we have respecting the use of the diving-bell in Europe is that of John Taisnier, quoted by Schott. The former, who was born at Hainault in 1509, had a place at court under Charles V, whom he attended on his voyage to Africa. He

Atque audivimus inventam esse jam machinam aliquam naviculae aut scaphae, quae homines subter aquis vehere possit ad spatia nonnulla [86]. Verum sub tali vase, quale modo diximus, corpora quaevis facile suspendi possint; cujus causa hoc experimentum adduximus.

Est et alius usus diligentis et perfectae clausurae corporum: nempe, non solum ut prohibeatur aditus aëris per exterius (de quo jam dictum est), verum etiam ut cohibeatur exitus spiritus corporis, super quod fit operatio per interius. Necesse est enim ut operanti circa corpora naturalia constet de summis suis: viz. quod nihil expirarit aut effluxerit. Fiunt enim profundae alterationes in corporibus, quando, natura prohibente annihilationem, ars prohibeat etiam deperditionem aut evolationem alicujus partis [87]. Atque hac de re invaluit opinio falsa (quae si vera esset, de ista conservatione summae certae absque diminutione esset fere desperandum): viz. spiritus corporum, et aërem majori gradu caloris attenuatum, nullis vasorum claustris posse contineri, quin per poros vasorum subtiliores evolent [88]. Atque in hanc opinionem adducti sunt homines per vulgata illa experimenta, poculi inversi super aquam cum candela aut charta inflammata, ex quo fit ut aqua sursum attrahatur; atque similiter ventosarum, quae super flammam calefactae trahunt carnes. Existimant enim in utroque experimento aërem attenuatum emitti [89], et inde *quantum* ipsius minui, ideoque

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relates in what manner he saw at Toledo [in 1538], in the presence of the emperor and several thousand spectators, two Greeks let themselves down under water, in a large inverted kettle, with a burning light, and rise up again without being wet.' The diving-bell was employed for the purpose of trying to recover part of the spoil, after the wreck of the Spanish Armada.

[86] Cp. New Atlantis, E. and S., vol. iii. p. 163: 'We have ships and boats for going under water, and brooking of seas.' Mr. Ellis, in a note on that passage, says that a boat for going under water was one of Drebbel's inventions exhibited in 1620. See also his note on De Augmentis, lib. v. cap. 2 (E. and S., vol. i. p. 628).

[87] Cp. the remarks on 'Spiritus' in ii. 40.

[88] The porosity of even the harder metals has been demonstrated by the Florentine and similar experiments.

[89] The air does not escape through the pores of the vessel; but, owing to its rarefaction, a portion of it has already escaped, before its application to the water or flesh.

aquam aut carnes per *nexum* succedere. Quod falsissimum est. Aër enim non *quanto* diminuitur, sed spatio contrahitur; neque incipit motus iste successionis aquae, antequam fiat extinctio flammae aut refrigeratio aëris: adeo ut medici, quo fortius attrahant ventosae, ponant spongias frigidas [90] aqua madefactas super ventosas [91]. Itaque non est cur homines multum sibi metuant de facili exitu aëris aut spirituum. Licet enim verum sit etiam solidissima corpora habere suos poros, tamen aegre patitur aër aut spiritus comminutionem sui ad tantam subtilitatem; quemadmodum et aqua exire recusat per rimam minusculam.

(2) De secundo vero modo ex septem praedictis illud imprimis notandum est, valere certe compressiones et hujusmodi violentias ad motum localem, atque alia id genus, potentissime; ut in machinis et missilibus: etiam ad destructionem corporis organici, atque earum virtutum quae consistunt plane in motu. Omnis enim vita, immo etiam omnis flamma et ignitio [92] destruitur per compressiones; ut et omnis machina corrumpitur et confunditur per easdem. Etiam ad destructionem virtutum quae consistunt in posituris, et dissimilaritate partium paulo crassiore; ut in coloribus (neque enim idem color floris integri et contusi, neque succini integri et pulverizati); etiam in saporibus (neque enim idem sapor pyri immaturi, et ejusdem compressi ac subacti; nam

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[90] Mr. Ellis proposes to read frigida, which is undoubtedly the right word. See the corresponding passage in the Historia Densi et Rari.

[91] These experiments are also described in the Historia Densi et Rari, E. and S., vol. ii. p. 267; in the Cogitationes De Natura Rerum, vol. iii. pp. 24–5; and in the Phaenomena Universi, vol. iii. p. 711. Notwithstanding what Mr. Kitchin says, I cannot see that Bacon's explanation in the text, so far as it goes, is wrong; though he certainly was not aware of the pressure of the atmosphere, and in the Historia Densi et Rari he himself refers the rising of the flesh within the cupping-glass to attraction 'per motum nexus.' Still, he is right in maintaining that the 'quantum' of the rarefied air within the cup is not diminished, but only the space which it previously filled contracted by cooling. The water or flesh which is covered by the vessel rises, as the heated air cools and contracts, this rising being, as we now know, due to the pressure of the atmosphere on the parts of the surface external to the vessel.

[92] Compression acts, in this case, by stopping the supply of oxygen which maintains the combustion.

manifesto dulcedinem majorem concipit). Verum ad transformationes et alterationes nobiliores corporum similarium non multum valent istae violentiae; quia corpora per eas non acquirunt consistentiam aliquam novam constantem et quiescentem, sed transitoriam, et nitentem semper ad restitutionem et liberationem sui. Attamen non abs re foret hujus rei facere experimenta aliqua diligentiora; ad hoc scilicet, utrum condensatio corporis bene similaris (qualia sunt aër, aqua, oleum, et hujusmodi), aut rarefactio similiter per violentiam indita, possint fieri constantes et fixae et quasi mutatae in naturam[93]. Id quod primo experiendum per moram simplicem; deinde per auxilia et consensus. Atque illud nobis in promptu fuisset (si modo in mentem venisset), cum aquam (de qua alibi[94]) per malleationes et pressoria condensavimus, antequam erumperet. Debueramus enim sphaeram complanatam per aliquot dies sibi permisisse, et tum demum aquam extraxisse; ut fieret experimentum, utrum statim impletura fuisset talem dimensionem, qualem habebat ante condensationem. Quod si non fecisset aut statim, aut certe paulo post, constans videlicet facta videri potuisset ista condensatio; sin minus, apparuisset factam fuisse restitutionem, et compressionem fuisse transitoriam. Etiam simile quiddam faciendum erat circa extensionem aëris in ovis vitreis[95]. Etenim debuerat fieri, post exuctionem fortem, subita et firma obturatio; deinde debuerant ova illa manere ita obturata per nonnullos dies; et tum demum experiendum fuisset, utrum aperto foramine attractus fuisset aër cum sibilo, aut etiam attracta fuisset tanta quantitas aquae post immersionem, quanta fuisset ab initio, si nulla adhibita fuisset mora. Probabile enim, aut saltem dignum probatione est, haec fieri potuisse et posse; propterea quod in corporibus paulo magis dissimilaribus similia efficiat mora temporis. Etenim baculum per compressionem curvatum post aliquod tempus non resilit; neque id imputandum est alicui deperditioni ex quanto ligni per

[93] Both gases and liquids are perfectly elastic; that is to say, after undergoing a change in volume, they regain exactly their original volume, when the original pressure is restored. This fact has been established by numerous experiments.

[94] ii. 45 ad fin.

[95] ii. 45.

moram; nam idem fiet in lamina ferri (si augeatur mora), quae non est expirabilis. Quod si non succedat experimentum per moram simplicem, tamen non deserendum est negotium, sed auxilia alia adhibenda. Non enim parum lucri fit, si per violentias indi possint corporibus naturae fixae et constantes. Hac enim ratione aër possit verti in aquam per condensationes[96], et complura alia id genus. Dominus enim est homo motuum violentorum, magis quam caeterorum.

(3) At tertius ex septem modis refertur ad magnum illud organum, tam naturae quam artis, quoad operandum; videlicet calidum et frigidum. Atque in hac parte claudicat plane potentia humana, tanquam ex uno pede. Habemus enim calorem ignis, qui caloribus solis (prout ad nos deferuntur) et caloribus animalium quasi infinitis partibus potentior est et intensior. At deest frigus[97], nisi quale per tempestates hyemales, aut per cavernas, aut per circundationes nivis et glaciei, haberi potest: quod in comparatione aequari potest cum calore fortasse solis meridiano in regione aliqua ex torridis, aucto insuper per reverberationes montium et parietum; nam hujusmodi utique tam calores quam frigora ab animalibus ad tempus exiguum tolerari possunt. Nihili autem sunt fere prae calore fornacis ardentis, aut alicujus

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[96] This remark has, no doubt, reference to Bacon's absurd theory of the Transmutability of the Elements. See Aph. 48 (11), with notes. But there is a certain sense in which his anticipation has been verified. For we now know that water might be produced, by means of cold and compression alone, from its constituent gases, hydrogen and oxygen. In fact, as already pointed out, all aeriform fluids are merely liquids kept in the state of vapour by heat, and a sufficient amount of cold and pressure will reduce them into the liquid state. See note 34 on Aph. 33.

[97] Bacon, it need hardly be repeated, regarded cold as a distinct quality from heat, not merely as a lower degree of it. The expression 'variations of temperature,' had it existed in his time, might, as I have already pointed out, have preserved him from this error.

The greatest cold known is produced by the evaporation of liquefied gases. By accelerating the evaporation of a bath of carbonic anhydride and ether, Faraday was enabled to obtain in the vacuum of the air-pump a degree of cold which he estimated at $-166°$ F. 'Natterer obtained a still more intense degree of cold than that produced by carbonic anhydride and ether *in vacuo*, by mixing liquid nitrous oxide with bisulphide of carbon, and placing the bath *in vacuo*; the lowest temperature which he has recorded is $-220°$ F.' See Miller's Elements of Chemistry, part i. § 196.

frigoris quod huic gradui respondeat. Itaque omnia hic apud nos[98] vergunt ad rarefactionem, et desiccationem, et consumptionem: nihil fere ad condensationem et intenerationem[99], nisi per misturas et modos quasi spurios. Quare Instantiae Frigoris omni diligentia sunt conquirendae: quales videntur inveniri in expositione corporum super turres quando gelat acriter; in cavernis subterraneis; circundationibus nivis et glaciei in locis profundioribus, et ad hoc excavatis; demissione corporum in puteos; sepulturis corporum in argento vivo et metallis; immersione corporum in aquis, quae vertunt ligna in lapides; defossione corporum in terra (qualis fertur apud Chinenses esse confectio porcellanae[1], ubi massae ad hoc

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[98] Here again (cp. Aph. 48 (12), (19)) he alludes to his theory of the rapidly increasing density of bodies, as we approach the centre of the earth.

[99] This is opposed to desiccationem. It is another of the numerous words employed by Bacon, which are not found in classical Latin. Nor is it recognised by Du Cange.

[1] Cp. Historia Densi et Rari, E. and S., vol. ii. p. 295; New Atlantis, E. and S., vol. iii. p. 157. Mr. Ellis refers to Marco Polo, ii. 77. In Marsden's Translation of Marco Polo (London, 1818), the passage runs as follows: 'They collect a certain kind of earth, as it were from a mine, and, laying it in a great heap, suffer it to be exposed to the wind, the rain, and the sun, for thirty or forty years, during which time it is never disturbed. By this it becomes refined and fit for being wrought into the vessels above mentioned. Such colours as may be thought proper are then laid on, and the ware is afterwards baked in ovens or furnaces. Those persons therefore who cause the earth to be dug, collect it for their children or grandchildren.' For the original, see Ramusio's Collection: 'Navigationi et Viaggi,' vol. ii. p. 49. The chapter is there numbered as 79.

From the general resemblance between what Bacon says and the passage in Marco Polo, I can entertain little doubt that he had read it, or some account taken from it. But, on the main point, it will be seen, the passages are discordant.

One of the numerous derivations of porcelain is the odd one 'pour cent années;' 'because it was believed by Europeans, that the materials of porcelain were matured under ground one hundred years.' Dr. Johnson's Dictionary. Cp. Sir Thomas Browne's Vulgar Errors, bk. ii. ch. 5 (Pickering's Ed., vol. ii. pp. 352–4). Several authorities are there cited both for and against this 'common belief.'

In Col. Yule's Edition of Marco Polo, the passage given above is rejected as an interpolation of Ramusio. Commenting on it, Col. Yule says: 'This story of the life-long period during which the porcelain clay was

factae dicuntur manere intra terram per quadraginta aut quinquaginta annos, et transmitti ad haeredes, tanquam minerae quaedam artificiales); et hujusmodi. Quinetiam quae interveniunt in natura condensationes, factae per frigora, similiter sunt investigandae; ut, causis eorum cognitis, transferri possint in artes. Quales cernuntur in exudatione marmoris et lapidum[2]; in rorationibus super vitra per interius fenestrarum, sub auroram, post gelu noctis; in originibus et collectionibus vaporum in aquas sub terra, unde saepe scaturiunt fontes[3]; et quaecunque sunt hujus generis.

Inveniuntur autem, praeter illa quae sunt frigida ad tactum, quaedam alia potestate frigida, quae etiam condensant; veruntamen operari videntur super corpora animalium tantum, et vix ultra. Hujus generis se ostendunt multa in medicinis et emplastris. Alia autem condensant carnes et partes tangibiles; qualia sunt medicamenta astringentia, atque etiam inspissantia: alia condensant spiritus; id quod maxime cernitur in soporiferis[4]. Duplex autem est modus condensationis spirituum, per medicamenta soporifera, sive provocantia somnum: alter per sedationem motus; alter per fugam spirituum. Etenim viola, rosa sicca, lactuca, et hujusmodi benedicta sive benigna, per vapores suos amicos et moderate refrigerantes, invitant spiritus ut se uniant, et ipsorum acrem et inquietum motum compescunt. Etiam aqua rosacea, apposita ad nares in deliquiis animae, spiritus resolutos et nimium relaxatos se recipere facit, et tanquam alit. At opiata et eorum affinia

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exposed to temper long held its ground, and probably was only dispelled by the publication of the details of the King-te-ching manufacture by Père d'Entrecolles in the Lettres Édifiantes.'

[2] This and the next phenomenon both fall under the general head of the Deposition of Dew. For references on this subject, see notes on Aph. 47. Cp. also Sylva Sylvarum, Exp. 81.

[3] Bacon's meaning will be made plain by the following marvellous passage in the Historia Densi et Rari (E. and S., vol. ii. p. 293): 'Existimatur origo fontium et aquarum dulcium, quae ex terra scaturiunt, fieri ex aere concluso in cavis terrae (praesertim montium) coagulato et condensato.' Cp. Arist. Meteorologica, i. 13 (p. 349 b. 19, &c.); Seneca, Nat. Quaest. iii. 9, 10. Granted the doctrine of the transmutability of the elements; this absurd theory seems natural enough.

[4] The reader will find some very curious remarks on these subjects in the Historia Vitae et Mortis, E. and S., vol. ii. pp. 161–71.

spiritus plane fugant, ex qualitate sua maligna et inimica. Itaque si applicentur parti exteriori, statim aufugiunt spiritus ab illa parte, nec amplius libenter influunt: sin sumantur interius, vapores eorum, ascendentes ad caput, spiritus in ventriculis cerebri contentos undequaque fugant; cumque se retrahant spiritus neque in aliam partem effugere possint, per consequens coëunt et condensantur; et quandoque plane extinguuntur et suffocantur; licet rursus eadem opiata moderate sumpta, per accidens secundarium (videlicet condensationem illam quae a coitione succedit), confortent spiritus, eosque reddant magis robustos, et retundant eorum inutiles et incensivos [5] motus, ex quo ad curas morborum, et vitae prolongationem haud parum conferant.

Etiam praeparationes corporum ad excipiendum frigus non sunt omittendae; veluti quod aqua parum tepida [6] facilius conglacietur quam omnino frigida, et hujusmodi.

Praeterea, quia natura frigus tam parce suppeditat, faciendum est quemadmodum pharmacopolae solent; qui, quando simplex aliquod haberi non possit, capiunt succedaneum [7] ejus, et *quid* pro *quo*, ut vocant: veluti lignum aloes pro xylobalsamo [8], cassiam pro cinamomo. Simili modo diligenter circumspiciendum est, si quae sint succedanea frigoris;

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[5] This word may mean 'inflammatory,' or it may simply be written for 'incentivos.'

[6] This happens because the freezing is assisted by the evaporation. The same, moreover, is true of water which has been previously boiled. The reason of this latter phenomenon is that the air combined with the water has been already discharged by the act of boiling, and hence the process of congelation is facilitated.

For notices of these phenomena amongst classical authors, see Arist. Meteorologica, i. 12 (p. 348 b. 30, κ. τ. λ.); Galen's Commentary on the Ἐπιδήμια of Hippocrates, lib. vi. comm. iv. (Kühn's Ed., vol. xvii. pt. ii. p. 155); Juvenal, Sat. v. 49–50 ('Frigidior Geticis petitur decocta pruinis'); Pliny, xxxi. 3 (23), sect. 40 (cp. with the last passage, Suetonius, Nero, cap. 48).

[7] Or *succidaneum*. The meaning of this word, in medical science, is obvious. It is an epithet for medicines that may be substituted for others possessing similar properties. There is a spurious work attributed to Galen, entitled Περὶ Ἀντεμβαλλομένων.

[8] These are twigs of the tree called Balsomodendron Gileadense. The celebrated Balsam of Gilead is an exudation from this tree.

videlicet quibus modis fieri possint condensationes in corporibus, aliter quam per frigus, quod illas efficit ut opus suum proprium. Illae autem condensationes videntur intra quaternum numerum (quantum adhuc liquet) contineri. Quarum prima videtur fieri per contrusionem simplicem; quae parum potest ad densitatem constantem (resiliunt enim corpora) sed nihilominus forte res auxiliaris esse queat. Secunda fit per contractionem partium crassiorum in corpore aliquo, post evolationem aut exitum partium tenuiorum, ut fit in indurationibus per ignem, et repetitis extinctionibus metallorum, et similibus. Tertia fit per coitionem partium homogenearum, quae sunt maxime solidae in corpore aliquo, atque antea fuerant distractae, et cum minus solidis commistae: veluti in restitutione mercurii sublimati, qui in pulvere longe majus occupat spatium quam mercurius simplex, et similiter in omni repurgatione metallorum a scoriis suis. Quarta fit per consensus[9], admovendo quae ex vi corporum occulta condensant; qui consensus adhuc raro se ostendunt; quod mirum minime est, quoniam antequam inventio succedat formarum et schematismorum, de inquisitione consensuum non multum sperandum est. Certe quoad corpora animalium, dubium non est quin sint complures medicinae, tam interius quam exterius sumptae, quae condensant tanquam per consensum, ut paulo ante diximus. Sed in inanimatis rara est hujusmodi operatio. Percrebuit sane, tam scriptis quam fama, narratio de arbore in una ex insulis sive Terceris[10] sive Canariis (neque enim bene memini), quae perpetuo stillat; adeo ut inhabitantibus nonnullam commoditatem aquae praebeat[11]. Paracelsus

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[9] That is, sympathies.

[10] Now called the Azores.

[11] 'This wonderful tree is described in Jonston's Dendrographia, published at Frankfort in 1669. See book the tenth, c. 4. One of the authorities he refers to is Cardan (De variet. rerum), from whom not improbably Bacon derived the story. The tree is said to be found in the island of Ferro. Cardan, with more than usual caution, remarks, at the close of the account he gives of it: "Sed postquam hoc tot scriptores affirmant, fieri potest ut tale aliquid contingat, sed modus nondum perspectus est."—De rerum variet. vi. c. 22.' Mr. Ellis' note. Mr. Ellis proceeds to refer to Ramusio. His reference, however, is altogether misleading. The true

autem ait, herbam vocatam *Rorem Solis*[12] meridie et fervente sole rore impleri, cum aliae herbae undique sint siccae. At nos utramque narrationem fabulosam esse existimamus. Omnino autem illae instantiae nobilissimi forent usus, et introspectione dignissimae, si essent verae. Etiam rores illos mellitos, et instar mannae, qui super foliis quercus inveniuntur mense Maio, non existimamus fieri et densari a consensu aliquo, sive a proprietate folii quercus; sed cum super aliis foliis pariter cadant, contineri scilicet et durare in foliis quercus, quia sunt bene unita, nec spongiosa, ut plurima ex aliis[13].

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one is to 'Della Historia Delle Indie, libro ii,' in Ramusio, vol. iii. p. 86 A.

Bacon's account of this tree is remarkably modest, as compared with that which Cardan reports. He says: 'Circa arborem singulo mane densa nebula colligitur, quae in aquam versa non solum hominibus, sed et jumentis et pecoribus satisfacit.'

The story may have originated in the observation of some plant which exudes moisture. Such plants are not uncommon, as, for instance, the Pitcher Plant, some of the Musas, the Drosera, next mentioned, &c. Or the plant may have been one on which dew is easily deposited and retained. Or, lastly, the cause might be the constant exudations of small insects. Mr. Andrew Johnson, who adopts this view, quotes Livingstone's Travels in South Africa, p. 415: 'I had an opportunity of observing a curious insect which inhabits trees of the fig family (ficus). Seven or eight of them cluster round a spot on one of the smaller branches, and there keep up a constant distillation of a clear fluid, which dropping to the ground forms a little puddle below. If a vessel is placed under them in the evening, it contains four or five pints of fluid in the morning.' Mr. Johnson adds: 'A careless observer might easily suppose this fluid to be the production of the tree itself.'

Lasalle has a long note on this passage. He quotes, in support of the story of the cloud hanging over the tree, an English navigator, one Robert Lade, and supplements the evidence by an observation of his own, in which he saw detached masses of fog clinging to the tops of trees. But Cardan's story seems to imply more than this rationalistic explanation of it.

[12] The Drosera (δροσερά) or Sun-Dew. The glands of the leaves exude drops of a clear glutinous fluid, glittering like dew-drops, whence the name.

Mr. Ellis says: 'I have not been able to find this in Paracelsus. It seems, however, to accord with his theory of dew,—namely, that it is an exudation from the sun and stars; the suppression of which would lead to the formation of additional suns.'

[13] The honey-dew on the oak, lime, rose-tree, plum-tree, &c., is in all probability due to a sugary exudation from the Aphis. For a description

Calorem vero quod attinet, copia et potestas nimirum homini abunde adest; observatio autem et inquisitio deficit in nonnullis, iisque maxime necessariis, utcunque spagyrici[14] se venditent. Etenim caloris intensioris opificia exquiruntur et conspiciuntur; remissioris vero, quae maxime in vias naturae incidunt, non tentantur, ideoque latent. Itaque videmus per vulcanos[15] istos qui in pretio sunt, spiritus corporum magnopere exaltari, ut in aquis fortibus, et nonnullis aliis oleis chymicis; partes tangibiles indurari, et, emisso volatili, aliquando figi; partes homogeneas separari; etiam corpora heterogenea grosso modo incorporari et commisceri; maxime autem compages corporum compositorum et subtiliores schematismos destrui et confundi. Debuerant autem opificia caloris lenioris tentari et exquiri; unde subtiliores misturae et schematismi ordinati gigni possint et educi, ad exemplum naturae et imitationem operum solis; quemadmodum in aphorismo de instantiis *foederis*[16] quaedam adumbravimus. Opificia enim naturae transiguntur per longe minores portiones, et posituras magis exquisitas et varias, quam opificia ignis, prout nunc adhibetur. Tum vero videatur homo revera auctus potestate[17], si per calores et potentias artificiales opera naturae possint specie repraesentari, virtute perfici, copia variari; quibus addere oportet accelerationem temporis. Nam rubigo ferri longo tempore procedit, at versio in crocum

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of this insect, its devastations, and its exudations, see the Rev. J. G. Wood's Insects at Home, p. 542, &c.

None of the three examples adduced by Bacon, it will be noticed, are really instances of 'condensation.' The phenomena all arise from exudation, either of the plant itself or of an insect settling on the plant.

[14] This word does not occur in Du Cange, but in Calepinus I find: '*spagirus*, alchymista, qui metalla coquens, purum ab impuro separat. Unde *spagiricus*, ad spagirum pertinens.' These and the allied words are of common occurrence in Paracelsus. In the De Natura Rerum, lib. viii. (Op. Omn. Genev. 1658, vol. ii. p. 104), he elaborately praises the 'Medici Spagyrici' in comparison with the other Medici.

There is a long and interesting account of this word in Kopp's Beiträge zur Geschichte der Chimie, Braunschweig, 1869, pp. 63-4, note. It was usually derived from *σπᾷν καὶ ἀγείρειν*, to separate and combine.

[15] 'Those fires,' as in Aen. vii. 77: 'Ac totis Vulcanum spargere tectis.'

[16] See ii. 35.

[17] Cp. i. 3.

Martis[18] subito; et similiter de aerugine et cerussa[19]. Christallum[20] longo tempore conficitur, vitrum subito conflatur. Lapides longo tempore concrescunt, lateres subito coquuntur, etc. Interim (quod nunc agitur) omnes diversitates caloris cum effectibus suis respective diligenter et industrie undique sunt colligendae et exquirendae: coelestium, per radios suos directos, reflexos, refractos, et unitos in speculis comburentibus; fulguris, flammae, ignis carbonum; ignis ex diversis materiis; ignis aperti, conclusi, angustiati, et inundantis, denique per diversas fabricas fornacium qualificati; ignis flatu exciti, quieti et non exciti; ignis ad majorem aut minorem distantiam remoti; ignis per varia media permeantis; calorum humidorum, ut balnei Mariae[21], fimi, caloris animalium per exterius, caloris animalium per interius, foeni conclusi; calorum aridorum, cineris, calcis, arenae tepidae; denique calorum cujusvis generis cum gradibus eorum.

Praecipue vero tentanda est inquisitio et inventio effectuum et opificiorum caloris accedentis et recedentis graduatim, et ordinatim, et periodice, et per debita spatia et moras. Ista enim inaequalitas ordinata revera filia coeli[22] est, et genera-

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[18] Sesqui-oxide of iron. 'Crocus' was a term applied by the older chemists to many metallic compounds, as Crocus Antimonii, Crocus Veneris, &c.

[19] 'Verdigris and white-lead.' Both these are classical terms.

[20] See ii. 48 (4) ad fin. with note.

[21] 'This is properly "balneum maris;" that is, a mode of communicating heat to any substance by putting it into a vessel which is placed in another containing water. The latter being put on the fire, the former and its contents become gradually and moderately heated. The reason of the name is obvious. From "balneum maris" the French made by a kind of translation (the final *s* not being sounded) "bain marie;" and the form in the text is, I think, merely a retranslation of the French phrase, the meaning of the second word being mistaken. Balneum Mariae is however, I believe, a common phrase with old writers on chemistry.' Mr. Ellis' note.

The expression 'Balneum Maris' occurs in Paracelsus, as, for instance, in the De Transmutatione Rerum, lib. vii. (Op. Omn. Genevae, 1658, vol. ii. p. 99 b). In turning over several old Manuals of Chemistry, I have found the expression 'Balneum Mariae' in Roflingius, Chimia, Geneva, 1671, p. 117. The modern equivalent is 'water-bath.'

[22] The heavenly bodies acting in this manner, as in the daily course of the sun, the seasons, and the imagined influence of the moon and stars.

tionis mater; neque a calore aut vehementi, aut praecipiti, aut subsultorio, aliquid magni expectandum est. Etenim et in vegetabilibus hoc manifestissimum est; atque etiam in uteris animalium magna est caloris inaequalitas, ex motu, somno, alimentationibus et passionibus foemellarum quae uterum gestant; denique in ipsis matricibus terrae, iis nimirum in quibus metalla et fossilia efformantur, locum habet et viget ista inaequalitas. Quo magis notanda est inscitia aliquorum alchymistarum ex reformatis[23], qui per calores aequabiles lampadum et hujusmodi, perpetuo uno tenore ardentium, se voti compotes fore existimarunt. Atque de opificiis et effectibus caloris haec dicta sint. Neque vero tempestivum est illa penitus scrutari, antequam rerum formae et corporum schematismi ulterius investigati fuerint, et in lucem prodierint. Tum enim quaerenda et adoperanda[24] et aptanda sunt instrumenta, quando de exemplaribus[25] constiterit.

(4) Quartus modus operandi est per moram, quae certe et promus et condus[26] naturae est, et quaedam dispensatrix. Moram appellamus, cum corpus aliquod sibi permittitur ad

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[23] 'Of the reformed school.' I suppose that Bacon alludes to Paracelsus and his disciples. They are described as the 'reformed school,' I presume, because they hoped to gain their ends by means of 'the lamp' rather than by the 'philosopher's stone.' But what Bacon complains of is that they thought their ends might be achieved without sufficiently varying the heat employed. It may be noticed that Paracelsus (who, however, still believed in the efficacy of the philosopher's stone; see, for instance, p. 100 a. of the treatise quoted below) enumerates various 'gradus ignis Alchymistici,' of which the 'jugis ignis candelae et lychni' is only one. See De Transmutatione Rerum, lib. vii. (Op. Omn., vol. ii. pp. 99, 100).

The student will find a good account of the reforms introduced into chemistry in the sixteenth century at the beginning of the second volume of Hoefer's Histoire de la Chimie. He enumerates three distinct schools: the école chémiatrique of Paracelsus, the école métallurgique of George Agricola, and the école technique of Bernard Palissy. It must be to the first of these, or at least to this mainly, I think that Bacon is here alluding.

[24] = adhibenda. See Du Cange, sub voce 'adoprare.'

[25] He must mean the exemplars or models ('rerum formae et corporum schematismi'), the operations of which the 'instrumenta' are to attempt to imitate.

[26] 'Distributer and store-keeper.' Cp. Plautus, Pseud. Act. ii. Sc. 2. l. 14: 'Condus promus sum.'

tempus notabile, munitum interim et defensum ab aliqua vi externa. Tum enim motus intestini se produnt et perficiunt, cum motus extranei et adventitii cessant. Opera autem aetatis sunt longe subtiliora quam ignis[27]. Neque enim possit fieri talis clarificatio vini per ignem, qualis fit per moram; neque etiam incinerationes per ignem tam sunt exquisitae, quam resolutiones et consumptiones per saecula. Incorporationes etiam, et mistiones subitae et praecipitatae per ignem, longe inferiores sunt illis, quae fiunt per moram. At dissimilares et varii schematismi, quos corpora per moras tentant (quales sunt putredines), per ignem aut calorem vehementiorem destruuntur. Illud interim non abs re fuerit notare; motus corporum penitus conclusorum habere nonnihil ex violento. Incarceratio enim illa impedit motus spontaneos corporis. Itaque mora in vase aperto plus facit ad separationes; in vase penitus clauso ad commistiones; in vase nonnihil clauso, sed subintrante aëre, ad putrefactiones. Utcunque de opificiis et effectibus morae undique sunt diligenter conquirendae instantiae.

(5) At regimen motus (quod est quintus ex modis operandi) non parum valet. Regimen autem motus vocamus, cum corpus aliud occurrens corporis alterius motum spontaneum impedit, repellit, admittit, dirigit. Hoc vero plerunque in figuris et situ vasorum consistit. Etenim conus erectus juvat ad condensationem vaporum in alembicis[28]; at conus inversus juvat ad defaecationem sacchari in vasis resupinatis[29]. Aliquando autem sinuatio requiritur, et angustiatio, et dilatatio per vices, et hujusmodi[30]. Etiam omnis percolatio huc

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[27] This comparison of time with fire is not uncommon. Cp. the end of Ovid's Metamorphoses (xv. 871–2):

> 'Jamque opus exegi, quod nec Jovis ira, nec ignes,
> Nec poterit ferrum, nec edax abolere vetustas.'

[28] A description of the Alembic, illustrated by a figure, will be found in Watts' Dictionary of Chemistry, sub voce. The instrument is now superseded by the Retort. It is possible, however, that Bacon is not speaking of the entire instrument, but only of the conical head.

[29] The ordinary wine-strainer will give a sufficiently good idea of what Bacon means.

[30] As in the Retort, called by the French 'cornue.' Old Books of

spectat; scilicet cum corpus occurrens uni parti corporis alterius viam aperit, alteri obstruit. Neque semper percolatio aut aliud regimen motus fit per extra; sed etiam per corpus in corpore: ut cum lapilli immittuntur in aquas ad colligendam limositatem ipsarum; syrupi clarificantur cum albuminibus ovorum, ut crassiores partes adhaerescant, et postea separari possint. Etiam huic regimini motus satis leviter et inscite attribuit Telesius[31] figuras animalium, ob rivulos scilicet et loculos matricis. Debuerat autem notare similem efformationem in testis ovorum, ubi non sunt rugae aut inaequalitas. At verum est regimen motus efformationes perficere in modulis et proplasticis[32].

(6) Operationes vero per consensus aut fugas (qui sextus modus est) latent saepenumero in profundo. Istae enim (quas vocant) proprietates occultae, et specificae[33], et sympathiae, et antipathiae[34], sunt magna ex parte corruptelae

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Chemistry, as, for instance, the Clavis of Gerardus Dorneus, Francf. 1583, shew this instrument to have been in common use in Bacon's time.

[31] 'Telesius's doctrine of the formation of the embryo is essentially the same as Galen's, namely that a system of arteries &c. must be first of all formed in the germ, and that these, by applying themselves to corresponding parts on the surface of the matrix, determine the channels through which nourishment is supplied, and therefore (mediately) the development of the different members of the foetus. But it does not seem that he would have admitted that the smoothness of the shells of eggs was an objection to his theory. At any rate, he illustrates it by reference to the appearances presented by an egg opened during incubation. De rerum natura, vi. chs. 4 and 40.' Mr. Ellis' note.

[32] Mr. Ellis says: 'The proper word for what we call a model is "proplasma," which is used in a Latin form by Pliny. I have not seen any authority for such an adjective as "proplasticus." What Bacon means is not exactly a model, but a mould for casting.' The reference to Pliny is Nat. Hist. xxxv. 12 (45), sect. 155. In Cicero, Epist. ad Atticum, xii. 41, the word is written in Greek.

[33] Cp. i. 66, and note 47.

[34] The remarks which Bacon presently proceeds to make are alone sufficient to shew how little right he had to complain of the fanciful views entertained by others on this class of questions. On the same subject, cp. Aditus ad Historiam Sympathiae et Antipathiae Rerum (E. and S., vol. ii. p. 81); Cogitata et Visa (E. and S., vol. iii. p. 606); Sylva Sylvarum, Exps. 95–97; and, on the kindred subject of Natural Magic, Nov. Org. ii. 9 ad fin., and ii. 31 ad fin., with the note on the latter passage, and the other places there referred to.

philosophiae. Neque de consensibus rerum inveniendis multum sperandum est, ante inventionem formarum et schematismorum simplicium. Consensus enim nil aliud est quam symmetria formarum et schematismorum ad invicem.

Atqui majores et magis catholici rerum consensus non prorsus obscuri sunt. Itaque ab iis ordiendum. Eorum prima et summa diversitas ea est; ut quaedam corpora copia et raritate materiae admodum discrepent, schematismis consentiant: alia contra copia et raritate materiae consentiant, schematismis discrepent. Nam non male notatum est a chymicis, in principiorum suorum triade[35], sulphur et mercurium quasi per uni-

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[35] This doctrine, that all bodies are composed of sulphur, mercury, and salt, seems to have been first introduced by Basilius Valentinus (whose works cannot, perhaps, be dated before the end of the fifteenth century. See the curious discussion on his personality, date, and writings in the Biographie Universelle), though it was largely developed by Paracelsus, and was the foundation of many of his chemical and medical speculations. See, especially, the Treatise 'De origine Morborum ex tribus primis substantiis,' Op. Omn. vol. i. p. 31, &c. The following extracts taken from lib. i. cap. 2 may be interesting and amusing to the reader: 'Nam si lignum manibus teneas, tunc oculorum judicio unum saltem corpus habes. Et hoc scire tibi nullo usui est. Idem et rustici sciunt videntque. Eo usque descendere et penetrare debes, ut scias, manibus te premere Sulphur, Mercurium et Sal. Quas tres res, si aspectu ipso, et tactu atque palpatu, unamquamlibet ab alia separatam sentis: tum demum oculos eos nactus es, quibus Medicus videre debet. Hi oculi in tribus his pervidendis tam perspicaces esse debent, quam certo lignum videt rusticus crudum. Hoc exemplum eo tibi faciat, ut ipsum hominem quoque in his tribus cognoscas, non minus ac ipsum lignum: hoc est, ipsum hominem simili forma conditum habeas. * * * * * * Id quod ardet, est sulphur. Praeter sulphur, nihil flagrat. Quod fumat, est Mercurius. Nihil sublimatur, praetur unum Mercurium. Quod in cinerem abit, Sal est. Nihil cinerescit, nisi sal sit.' The members of this triad, however, were not the common, visible substances of sulphur, mercury, and salt, but certain pure substances, analogous to these, and possessing in perfection the respective properties of burning, of being volatile, and of being fixed. See, for a further account, Kopp's Geschichte der Chemie, Braunschweig, 1843, Th. i. pp. 88–9; 96–7.

The earlier view of Geber (who lived in the eighth century), adopted apparently from his predecessors, was that the metals were composed of only two substances (these, as in the theory of Paracelsus, being pure, not the common, visible, substances), namely, sulphur and mercury. See Kopp, Th. i. pp. 44–6. To this earlier view Bacon recurs, applying it, however, apparently, to bodies in general.

versitatem rerum permeare. (Nam de sale inepta ratio est, sed introducta ut possit comprehendere corpora terrea, sicca, et fixa[36].) At certe in illis duobus videtur consensus quidam naturae ex maxime catholicis conspici. Etenim consentiunt sulphur; oleum, et exhalatio pinguis; flamma; et fortasse corpus stellae[37]. Ex altera parte consentiunt mercurius;

In the Cogitata et Visa (E. and S., vol. iii. p. 605), Bacon says: 'Utcunque enim Principiorum Trias inventum non inutile fuerit, sed rebus aliqua ex parte finitimum.' Cp. Temporis Partus Masculus (E. and S., vol. iii. pp. 532–3): 'Principiorum autem triadem, commentum haud ita prorsus inutile et rebus aliqua ex parte finitimum, quam importune inculcat homo imposturae peritissimus?' See also Sylva Sylvarum, Exp. 354, and Aditus ad Historiam Sulphuris, Mercurii, et Salis (E. and S., ii. pp. 82–3).

[36] As opposed to volatile. See last note.

[37] The idea of 'quaternions' is still further and more clearly developed in the Aditus ad Historiam Sulphuris, &c., just referred to. There, he regards sulphur and mercury, which properly belong to the subterranean world, as taking the forms respectively of oil and water in the animal and vegetable world, of flame and air respectively 'in pneumaticis inferioribus,' and, lastly (though about this he does not pronounce decisively), of starry matter and pure aether respectively 'in coelestibus.' Salt he regards as compounded of sulphur and mercury, by means of a strong spirit. The reader should carefully compare this 'Aditus' with the present passage, and with what was said about the Triad in the last note but one.

I have not been able to find in the works of Paracelsus any single passage or any combination of passages containing the precise theory propounded in the text. But the following quotations, which are necessarily very brief, will shew that much of this nonsense was either derived directly from Paracelsus, or indirectly suggested by his works:

'Sulphurum multa sunt: Resina, Gummi, Botin [id est Terpentina], Axungia, pinguedo, butyrum, oleum, vinum ardens, &c.'

'Scitote ergo, salia multa esse. Quaedam sunt calces: quaedam cineres: quaedam Arsenicalia: quaedam Antimonicalia, &c.' Op. Omn. vol. i. p. 36 a.

'Sal albus est: et omnes in se colores habet. Sulphur ardet. Ideo omnia olea continet. Mercurius diffluit. Ergo omnes in se humores claudit. Et sic de caeteris quoque, quae ad philosophiam remittimus.' i. p. 52 b.

'Pinguedo autem quaevis nihil est aliud quam sulphur modis ac naturis variis divisum. * * * Videtis nimirum per tempestates coelum fulgurare. Isto autem loco sulphur nullum videri potest. Et tamen cum ardeat, id necessario a solo sulphure fit.' i. 710 a.

Even these absurdities are outdone by the quaint theory of Paracelsus about the stars (and here Bacon ceases to follow): 'Sydera omnia Hyemis

aqua et vapores aquei; aër; et fortasse aether purus et interstellaris. Attamen istae quaterniones geminae, sive magnae rerum tribus (utraque intra ordines suos), copia materiae atque densitate immensum differunt, sed schematismo valde conveniunt; ut in plurimis se produnt. At contra metalla diversa copia et densitate multum conveniunt (praesertim respectu vegetabilium, &c.), sed schematismo multifariam differunt; et similiter vegetabilia et animalia diversa schematismis quasi infinitis variantur, sed intra copiam materiae sive densitatem paucorum graduum continentur.

Sequitur consensus maxime post priorem catholicus, videlicet corporum principalium et fomitum suorum; videlicet menstruorum[38], et alimentorum. Itaque exquirendum, sub quibus climatibus, et in qua tellure, et ad quam profunditatem metalla singula generentur; et similiter de gemmis, sive ex rupibus, sive inter mineras natis; in qua gleba terrae, arbores singulae, et frutices, et herbae potissimum proveniant, et tanquam gaudeant; et insimul quae impinguationes, sive per stercorationes cujuscunque generis, sive per cretam, arenam maris, cineres, &c., maxime juvent; et quae sint ex his pro varietate glebarum magis aptae et auxiliares. Etiam insitio et inoculatio arborum et plantarum, earumque ratio, quae scilicet plantae super quas

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vivunt in Mercurio, et sydera omnia aestatis in sulphure, et juxta se invicem ita manent jugiter.' i. 824 b.

I cannot but think that Bacon, in his modifications of the doctrine of Paracelsus, was influenced by the theory of Telesius, deriving all things from heat and cold; sulphur would answer to the former, mercury to the latter. The manner in which Bacon constructs his 'Quaternions' would certainly support this hypothesis.

[38] 'By "menstrua" are meant the substances out of which any species of mineral is generated, or, in other words, the causa materialis of its existence. See, on the generation of metals and other minerals, the fourth and fifth books of [Georgius] Agricola's work De ortu et causis Fossilium [? subterraneorum]. He gives an account of the opinions of Aristotle, Theophrastus, &c. In modern chemistry the word menstruum is nearly equivalent to solvent. By the school of Paracelsus the word is used so vaguely that it is difficult to determine what idea they attached to it, or how they derived their sense of the word from its original signification. When the word is used as in the text, the metaphor seems to be taken from the Aristotelian theory of generation, in which *κατὰ τὴν πρώτην ὕλήν ἐστιν ἡ τῶν καταμηνίων φύσις.*' [De Gen. An. i. 20 ad fin. p. 729 a. 32.] Mr. Ellis' note.

foelicius inserantur, &c., multum pendet de consensu. In qua parte non injucundum foret experimentum[39], quod noviter audivimus esse tentatum, de insitione arborum sylvestrium (quae hucusque in arboribus hortensibus fieri consuevit), unde folia et glandes majorem in modum amplificantur, et arbores fiunt magis umbrosae. Similiter, alimenta animalium respective notanda sunt in genere, et cum negativis. Neque enim carnivora sustinent herbis nutriri; unde etiam Ordo Folitanorum[40] (licet

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[39] See Sylva Sylvarum, Exp. 475.

[40] Bacon alludes to these monks on two other occasions, namely in the Historia Vitae et Mortis (E. and S., vol. ii. p. 131), where he calls them Foliatani, and in the Sylva Sylvarum, Exp. 45, where he calls them Foliatanes.

I borrow the following note from Mr. Ellis: 'Bacon doubtless refers to the austerities of the order of Feüillans. Jean de la Barrière, after holding the Cistercian abbey of Feüillans in commendam for eleven years, renounced the world in 1573, and in the course of a few years introduced a most austere rule of life into the abbey of which he was the head. His monks knelt on the floor during their refections, and some of them were in the habit of drinking out of skulls. They abstained from eggs, fish, butter, oil, and even salt, and confined themselves to pottage made of herbs boiled in water, and bread so coarse and black that beasts refused to eat of it. After a while they gave up wine also. Clement VIII permitted the society to draw up constitutions for the establishment of their rule. By these the excessive rigour of their way of life was checked, which was done in obedience to the Pope, and in consequence of the deaths of fourteen monks in a single week at Feüillans. These constitutions were ratified in 1595. Assuming, of which there seems no doubt, that the Folitani of Bacon are the Feüillans, I may remark that the Latinised form of Feüillans used is Fuliensis, as an adjective; the proper style of the society being "Congregatio Cistertiomonastica B. Mariae Fuliensis." I have not seen the work of Morotius to which Helyot, from whom the preceding account is taken, refers; but in that of C. Henrique, also mentioned by Helyot, I do not find any authority for Folitani. It is probable that Bacon's chief information on the subject was gathered orally during his residence in France, before the Feüillans had ceased from their first love. The expression "ordo * * * fere evanuit" must be taken to mean that the severe rule that they had at first was given up. See Helyot, Hist. des Ordres Monastiques, ivme partie, c. 38. [Tome v.] Spondanus, An. 1586, iv. For some particulars of the early history of the Abbey of Feüillans, and especially for the will of Jean de la Barrière, see Voyage Littéraire de deux Bénédictins, ii. p. 16.'

The Histoire des Ordres Monastiques was published anonymously at Paris, in 8 vols., the first appearing in 1714. In the Voyage Littéraire, &c. (which was written by Edm. Marténe and Urs. Durand), there occurs a copy

voluntas humana plus possit quam animantium caeterorum super corpus suum[41]), post experientiam factam (ut aiunt), tanquam ab humana natura non tolerabilis, fere evanuit. Etiam materiae diversae putrefactionum, unde animalcula generantur, notandae sunt.

Atque consensus corporum principalium erga subordinata sua[42] (tales enim ii possint censeri quos notavimus) satis in aperto sunt. Quibus addi possunt sensuum consensus erga objecta sua. Qui consensus, cum manifestissimi sint, bene notati, et acriter excussi, etiam aliis consensibus qui latent magnam praebere possint lucem.

At interiores corporum consensus et fugae, sive amicitiae et lites (taedet enim nos fere vocabulorum sympathiae et antipathiae, propter superstitiones et inania), aut falso ascriptae, aut fabulis conspersae, aut per neglectum[43] rarae admodum sunt. Etenim si quis asserat inter vineam et brassicam[44] esse

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of a Bull, in which the Latinised form of the Order is Congregatio Feuillensis. I have looked through the book of Morotius (a copy of which is in the Bibliothèque Nationale), entitled 'Cistercii Reflorescentis, seu Cong. Cistercio-Monasticarum B. Mariae Fuliensis in Gallia et Reformatorum S. Bernardi in Italia, Chronologica Historia,' Turin, 1690, and find that these monks are there styled 'Fulienses,' and never, so far as my observation extends, Folitani.

[41] On the reciprocal action of Mind and Body, see De Augm. iv. 1 (E. and S., vol. i. pp. 583–6).

[42] This is somewhat obscure, but what is meant, I think, is the consent between the 'corpora principalia' and their 'fomites,' the latter being regarded as 'subordinate' to the use of the former. The sentence, therefore, is simply a reference back to the last paragraph.

[43] That is, through negligence in observing them. Some of the later editions have a comma after 'neglectum,' which makes the passage unintelligible.

[44] The cabbage. For its medicinal properties, and its varieties, see Cato de Re Rustica, 156–7. He says: 'Si voles in convivio multum bibere, coenareque libenter, ante coenam esto crudam quantum voles ex aceto. Et item ubi coenaveris, comesto aliqua. Ubi folia reddent te quasi nihil ederis; biberisque bibesque quantum voles.' Cp. Columella, xii. 3.

Mr. Kitchin refers to Cicero, De Natura Deorum, ii. 47: 'Age ut a caelestibus rebus ad terrestres veniamus; quid est in his, in quo non naturae ratio intelligentis appareat? * * * Jam vero vites sic claviculis adminicula, tanquam manibus, apprehendunt, atque se ita erigunt, ut animantes. Quin etiam a caulibus brassicisque, si propter sati sint, ut

dissidium, quia juxta sata minus laete proveniunt, praesto ratio est: quod utraque planta succulenta sit et depraedatrix, unde altera alteram defraudat. Si quis asserat esse consensum et amicitiam inter segetes et cyaneum[45], aut papaver sylvestre, quia herbae illae fere non proveniunt nisi in arvis cultis: debuit is potius asserere dissidium esse inter ea, quia papaver et cyaneus emittuntur et creantur ex tali succo terrae qualem segetes reliquerint et repudiaverint; adeo ut satio segetum terram praeparet ad eorum proventum. Atque hujusmodi falsarum ascriptionum magnus est numerus. Quoad fabulas vero, illae omnino sunt exterminandae. Restat tenuis certe copia eorum consensuum, qui certo probati sunt experimento; quales sunt magnetis et ferri, atque auri et argenti vivi, et similium. At in experimentis chymicis circa metalla inveniuntur et alii nonnulli observatione digni. Maxima vero frequentia eorum (ut in tanta paucitate) invenitur in medicinis nonnullis[46], quae, ex proprietatibus suis occultis (quas vocant)

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a pestiferis, et nocentibus, refugere dicuntur, nec eos ulla ex parte contingere.' For the virtues of Brassica (κράμβη) as a remedy against the effects of intoxication, Mr. Kitchin refers to Athenaeus, Deipn. i. p. 34 C–F (end of bk. i). Athenaeus gives a number of authorities, and, as a proof of the addiction of the Egyptians to wine, says that they invariably commence their chief meal (δεῖπνον) by eating boiled cabbage.

Pliny frequently speaks of 'brassica.' See, for instance, Nat. Hist. xx. 9 (33–8), sect. 78, &c., where he notices the opinion 'vino adversari ut inimicum vitibus, antecedente in cibis caveri ebrietatem, postea sumpta crapulam discuti.' Again, in xxiv. 1. sect. 1, he says: 'Pernicialia et brassicae cum vite odia; ipsum olus, quo vitis fugatur, adversum cyclamino et origano arescit.' In the pseudo-Aristotelian treatise, the Problems, we find the question put: Διὰ τί ἡ κράμβη παύει τὴν κραιπάλην; Prob. iii. 17 (873 a. 37).

As to later writers, Mr. Ellis refers to Lemnius, De Occultis Naturae Miraculis, ii. 17. I have no doubt that other authorities might easily be found, but this note is already too long.

On similar 'discordiae atque concordiae,' as, for instance, the enmity between the olive and the oak, see Pliny, xxiv. 1. Mr. Ellis refers to Lemnius, De Occultis, &c., iv. 10, to Cardan, De Rerum Varietate (see, for instance, lib. i. cap. 1), and to the Theatrum Sympatheticum. The last book, which is very curious, and, amongst other things, treats of Digby's Sympathetic Powder, was published at Nuremberg in 1660.

[45] Properly cyanus, κύανος, the corn-flower. See Pliny, Nat. Hist. xxi. 8 (24), sect. 48; 11 (39), sect. 68.

[46] Ancient medicine is so full of these absurd analogies, that it is almost

et specificis, respiciunt aut membra, aut humores, aut morbos, aut quandoque naturas individuas [47]. Neque omittendi sunt consensus inter motus et affectus lunae et passiones corporum inferiorum, prout ex experimentis agriculturae [48], nauticae [49],

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superfluous to give any instances. See, for example, Paracelsus, passim, and especially the treatises De Origine Morborum and De Morbis Tartareis, as well as the works referred to at the end of the last note but one. The 'Doctrine of Signatures' was one of the most absurd forms under which this conceit appeared. See Paracelsus, De Signatura Rerum (Op. Omn., vol. ii. pp. 106–16), and, for a good modern account of the theory, Dr. Paris' Pharmacologia, p. 47, &c. From the latter work, I have extracted several sentences on this subject in the last chapter of my Inductive Logic (see 3rd Ed., pp. 347–9). Dr. Paris defines the doctrine as a 'belief that *every natural substance, which possesses any medicinal virtues, indicates, by an obvious and well-marked external character, the disease for which it is a remedy, or the object for which it should be employed.*' He instances mandrake as a cure for sterility, the lungs of a fox as a specific for asthma, poppies for diseases of the head, turmerick for jaundice, euphrasia (eye-bright) for complaints of the eye, blood-stone for bleeding at the nose, &c., &c.

[47] Of this kind was the sympathetic powder, invented at a later period by Sir Kenelm Digby. See last note on Aph. 31. The particular weapon which had inflicted the wound was anointed for the purpose of curing the particular person suffering. To the same head belong incantations practised on an effigy of the person whom it was intended to affect, or on his clothes, or on his cut hair or nails, &c.

Of a similar character was the belief that particular cures could only be performed by particular people, as in the case of the King's Evil.

[48] See Hesiod, Opera et Dies, 765–828; Virgil, Georgics, i. 276–86; Pliny, Nat. Hist. xviii. 32 (75), 28 (68), and other passages; Aulus Gellius, xx. 8. Some of the directions given by Pliny are of a very odd character. Thus, 'stercus nisi decrescente luna ne tangito * * * ova luna nova subponito. scrobis luna plena noctu facito. arborum radices luna plena operito,' &c.

Cp. Tylor's Primitive Culture, vol. i. p. 130 (2nd Ed.). He quotes Tusser's Five Hundred Points of Husbandry:

'Sowe peason and beans in the wane of the moone,
Who soweth them sooner, he soweth too soone:
That they, with the planet, may rest and rise,
And flourish with bearing, most plentiful wise.'

Cardan (De Rerum Varietate, lib. ii. cap. 13) has some curious remarks on the same subject.

[49] He here alludes to the supposed correspondence between the appearances of the moon and the weather. See Virgil, Georgics, i. 424–37, and the corresponding passage in Aratus, Διοσημεῖα, p. 46, &c.; Pliny, Nat.

et medicinae[50], aut alias[51] cum delectu severo et sincero colligi et recipi possint. Verum instantiae universae consensuum secretiorum, quo magis sunt infrequentes, eo majori cum diligentia sunt inquirendae, per traditiones, et narrationes fidas et probas; modo hoc fiat absque ulla levitate, aut credulitate, sed fide anxia et quasi dubitabunda. Restat consensus corporum modo operandi tanquam inartificialis, sed usu polychrestus, qui nullo modo omittendus est, sed sedula observatione investigandus. Is est coitio sive unio

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Hist. ii. 47 (48); xviii. 28 (68), 35 (79), and other passages. The last passage quoted from Pliny contains an interesting extract from Varro. To the same head belongs the influence of the moon on the Tides, so far as that was recognised in the older systems of Physics.

[50] See, for instance, Pliny, Nat. Hist. ii. 99 (102), sect. 221: 'Quo vera conjectatio exsistit, haud frustra spiritus sidus Lunam existimari. Hoc esse quod terras saturet, accedensque corpora impleat, abscedens inaniat. Ideo cum incremento ejus augeri conchylia; et maxime spiritum sentire, quibus sanguis non sit. Sed et sanguinem hominum etiam cum lumine ejus augeri ac minui: frondes quoque ac pabula (ut suo loco dicetur) sentire, in omnia eadem penetrante vi.' Hence, the idea that blood should be let or herbs gathered at certain phases of the moon, or that it was more dangerous to be wounded under certain signs or at certain phases of the moon than at others. Paracelsus combats the latter theories in his work De Phlebotomia (Op. Omn., vol. i. p. 766, &c.): 'Morbus spectandus est, non coelum.' But he adheres to the old opinion as to the season for gathering herbs. See the treatise De Philosophia (Op. Omn., vol. ii. pp. 502–3): 'Ex Lunae facie, ipsum decrementum (sc. optimum esse), maxime quod tribus ultimis diebus finitur, mane nimirum, sub diei auspicium. Sicut enim homo diei decursu laborat, eoque labore confecto lassus et enervis nocturna quiete sese reficit, et instaurat vires: sic etiam fructus omnes et nascentia terrae, radices, herbae,' &c., with much more to the same purport.

On the beliefs that warts could be eradicated by exposing them to the rays of the moon, and that the wounded should not be exposed to these rays, 'ne livor succedat, et sanatio procrastinetur,' see the Theatrum Sympatheticum, pp. 210–2, and cp. Sir Thomas Browne's Vulgar and Common Errors, vol. iii. pp. 182–3.

Lunacy, the intervals and paroxysms of which were supposed to vary with the phases of the moon, is another instance in point. The madness was supposed to culminate with the Full Moon, and to receive a reinforcement, as it were, with the New Moon. For a very curious account and explanation of these theories, see Paracelsus, De Morbis Amentium, Op. Omn. i. 573.

[51] See, for instances, Pliny, Nat. Hist. xxviii. 7 (23); xiv. 21 (27); ii. 9 (6), 101 (104).

corporum, proclivis aut difficilis, per compositionem, sive appositionem simplicem[52]. Etenim corpora nonnulla facile et libenter commiscentur et incorporantur, alia autem aegre et perverse: veluti pulveres melius incorporantur cum aquis; calces et cineres, cum oleis; et sic de similibus. Neque tantum sunt colligendae instantiae *propensionis* aut *aversionis* corporum erga misturam, sed etiam collocationis partium, et distributionis, et digestionis, postquam commista sint; denique et praedominantiae post misturam transactam.

(7) Superest ultimo loco ex modis septem operandi septimus et postremus: operatio scilicet per alternationem[53] et vicissitudines priorum sex; de quo antequam in singulos illos paulo altius fuerit inquisitum, tempestivum non foret exempla proponere. Series autem sive catena hujusmodi alternationis, prout ad singula effecta accommodari possit, res est et cognitu maxime difficilis, et ad opera maxime valida. Summa autem detinet et occupat homines impatientia hujusmodi tam inquisitionis, quam praxeos; cum tamen sit instar fili labyrinthi[54], quoad opera majora. Atque haec sufficiant ad exemplum Polychresti.

LI.

Inter *praerogativas instantiarum*, ponemus loco vicesimo septimo atque ultimo *Instantias Magicas*[55]. Hoc nomine illas appellamus, in quibus materia aut efficiens tenuis aut parva est, pro magnitudine operis et effectus qui sequitur; adeo ut etiamsi fuerint vulgares, tamen sint instar miraculi; aliae primo intuitu, aliae etiam attentius contemplanti. Has vero natura ex sese subministrat parce; quid vero factura sit sinu excusso, et

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[52] That is, by chemical mixture or mechanical composition.

[53] 'That is, by bringing these six different methods to bear in judicious order on each subject, and so shifting that order as to gather different results —as, e.g. using Heat before or after pressure,' &c. Mr. Kitchin's note.

[54] This is the title of no less than three of Bacon's smaller works. They will be found in the second and third volumes of Ellis and Spedding's Edition.

[55] These 'instances' occur, where great effects are produced by means apparently inadequate. Bacon hoped that, as we come to know more of 'Forms,' of the inner constitution of bodies, and of the latent processes by which changes in their constitution are brought about, these instances would become far more numerous.

post inventionem formarum, et processuum, et schematismorum, futuris temporibus apparebit. At ista effecta magica (quantum adhuc conjicimus) fiunt tribus modis: aut per multiplicationem sui[56], ut in igne, et venenis, quae vocant specifica[57]; necnon in motibus, qui transeunt et fortificantur de rota in rotam[58]: aut per excitationem[59] sive invitationem in altero, ut in magnete, qui excit acus innumeras, virtute nullatenus deperdita aut diminuta; aut in fermento, et hujusmodi: aut per anteversionem motus[60], ut dictum est de pulvere pyrio, et bombardis, et cuniculis: quorum priores duo modi indagationem consensuum requirunt; tertius, mensurae motuum. Utrum vero sit aliquis modus mutandi corpora per minima[61] (ut vocant), et transponendi[62] subtiliores materiae

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[56] See Aph. 48 (11).

[57] By a Specific Poison is properly meant a poison which is invariably attended by the same group of *sequelae*, in opposition to a poison, the effect of which is different under different circumstances and on different constitutions. Most specific poisons, such as small-pox, measles, the Morbus Gallicus, &c., possess the power of self-multiplication, but this is not an invariable property of such poisons. Thus, in lucifer-match manufactories, phosphorus produces necrosis of the lower jaw, and may, therefore, be regarded as a specific poison, but it does not act by way of self-multiplication.

In ii. 48 (12), Bacon refers the action of 'some poisons' to the 'motus excitationis.'

[58] This is the principle of the Wheel and Axle. But, as Mr. Kitchin observes, the 'fortificatio motus' takes place at the expense of speed.

[59] See Aph. 48 (12).

[60] See ii. 36 (7), 48 (10). The motion of the nitre, from its abhorrence of flame, is supposed to 'anticipate' that of the sulphur.

[61] In their smallest portions, or atoms. Cp. the expression 'latio per minima' in i. 50. This is the second of the two modes of transformation, spoken of at the beginning of ii. 5.

[62] We have already seen that the transformation of bodies was a cherished idea of Bacon. See especially my Introduction, § 6, and the Aphorisms at the beginning of this Book, with the notes. On the transmutation of the metals, there are some very curious and interesting remarks in the Historia Densi et Rari, E. and S., vol. ii. pp. 250–1. There he gives it as his opinion that other bodies cannot be turned into Gold, on account of its superior density, but that we may hope to effect the conversion of lead or quicksilver into silver. Cp., on this subject, De Augmentis, lib. iii. cap. 5 (E. and S., vol. i. p. 574). In the Sylva Sylvarum, Exps. 326–8, he seems to be more hopeful, and actually proposes a recipe for the making of gold.

The last sentence of the Aphorism is an attack on the Alchemists, who

schematismos (id quod ad omnimodas corporum transformationes pertinet, ut ars brevi tempore illud facere possit, quod natura per multas ambages molitur), de eo nulla hactenus nobis constant indicia. Quemadmodum autem in solidis et veris aspiramus ad ultima et summa; ita vana et tumida perpetuo odimus, et quantum in nobis est profligamus.

LII.

Atque de Dignitatibus sive *Praerogativis Instantiarum* haec dicta sint. Illud vero monendum [63], nos in hoc nostro *Organo* tractare logicam, non philosophiam. Sed cum logica nostra doceat intellectum et erudiat ad hoc, ut non tenuibus mentis quasi claviculis rerum abstracta captet et prenset (ut logica vulgaris), sed naturam revera persecet [64], et corporum virtutes et actus [65] eorumque leges in materia determinatas inveniat; ita ut non solum ex natura mentis, sed ex natura rerum [66] quoque haec scientia emanet: mirum non est, si ubique naturalibus contemplationibus et experimentis, ad exempla artis nostrae, conspersa fuerit et illustrata [67]. Sunt autem (ut ex iis quae dicta sunt patet) *Praerogativae Instantiarum* numero 27; nominibus: *Instantiae Solitariae: Instantiae Migrantes: Instantiae Ostensivae: Instantiae Clandestinae: Instantiae Constitutivae: Instantiae Conformes: Instantiae Monodicae: Instantiae Deviantes: Instantiae Limitaneae: Instantiae Potestatis: Instantiae Comitatus et Hostiles: Instantiae Subjunctivae: Instantiae Foederis: Instantiae Crucis:*

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hoped to obtain their ends by means of an Elixir or the Philosopher's Stone.

[63] This is a good statement of the objects of the Baconian reform, which was intended, in the first instance, to bring about a change of method rather than a change of doctrine; but a change of doctrine, Bacon felt assured, would soon follow the change of method.

[64] Cp. i. 51, and i. 13.

[65] That is, 'actus puros,' manifestations. See i. 51, with the note on this expression.

[66] As every true system of logic ought to do. Logic, like any other science, unless its generalisations are constantly brought to the bar of experience, and submitted to the test of facts, external as well as internal, must become abstract, barren, and worthless.

[67] And yet we cannot but regret that Bacon has not also supplied us, in pursuance of what he says in i. 127, with examples from the mental, moral, and political sciences, in which his experience was so rich.

Instantiae Divortii: Instantiae Januae: Instantiae Citantes: Instantiae Viae: Instantiae Supplementi: Instantiae Persecantes: Instantiae Virgae: Instantiae Curriculi: Doses Naturae: Instantiae Luctae: Instantiae Innuentes: Instantiae Polychrestae: Instantiae Magicae. Usus autem harum *instantiarum*, in quo instantias vulgares excellunt, versatur in genere aut circa partem informativam; aut circa operativam; aut circa utramque. Atque quoad informativam, juvant illae aut sensum, aut intellectum. Sensum, ut quinque *Instantiae Lampadis*[68]: intellectum, aut accelerando exclusivam formae, ut *Solitariae;* aut angustiando et propius indicando affirmativam formae, ut *Migrantes, Ostensivae, Comitatus,* cum *Subjunctivis;* aut erigendo intellectum, et ducendo ad genera et naturas communes; idque aut immediate, ut *Clandestinae, Monodicae, Foederis;* aut gradu proximo, ut *Constitutivae;* aut gradu infimo, ut *Conformes;* aut rectificando intellectum a consuetis, ut *Deviantes;* aut ducendo ad Formam Magnam, sive Fabricam Universi[69], ut *Limitaneae;* aut cavendo de formis et causis falsis, ut *Crucis* et *Divortii.* Quod vero ad Operativam attinet; illae practicam aut designant, aut mensurant, aut sublevant. Designant aut ostendendo a quibus incipiendum, ne actum agamus, ut *Instantiae Potestatis;* aut ad quid aspirandum, si detur facultas, ut *Innuentes:* mensurant quatuor illae *Mathematicae*[70]: sublevant *Polychrestae* et *Magicae.*

Rursus ex istis *instantiis* 27, nonnullarum (ut superius diximus de aliquibus) facienda est collectio jam ab initio, nec expectanda particularis inquisitio naturarum. Cujus generis sunt *instantiae conformes, monodicae, deviantes, limitaneae, potestatis, januae, innuentes, polychrestae, magicae.* Hae enim aut auxiliantur et medentur intellectui et sensui, aut instruunt praxin in genere. Reliquae tum demum conquirendae sunt, cum conficiemus *tabulas comparentiae* ad opus interpretis circa aliquam naturam particularem. Sunt enim *instantiae*

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[68] See Aphs. 38–43.

[69] That is, the κόσμος. Cp. Aph. 30: 'optime enim indicant compositionem et fabricam rerum.'

[70] Namely, the Instantiae Virgae, Instantiae Curriculi, Instantiae Quanti, and Instantiae Luctae.

praerogativis istis insignitae et donatae animae instar, inter vulgares instantias comparentiae; et ut ab initio diximus [71], paucae illarum sunt vice multarum; quocirca cum *tabulas* conficimus, illae omni studio sunt investigandae, et in *tabulas* referendae. Erit etiam earum mentio necessaria in iis quae sequuntur. Praeponendus itaque erat earum tractatus. Nunc vero ad *adminicula* et *rectificationes Inductionis*, et deinceps ad *concreta* [72], et *latentes processus*, et *latentes schematismos*, et reliqua quae Aphorismo 21. ordine proposuimus, pergendum; ut tandem (tanquam curatores probi et fideles) tradamus hominibus fortunas suas, emancipato intellectu, et facto tanquàm majore: unde necesse est sequi emendationem status hominis, et ampliationem potestatis ejus super naturam [73]. Homo enim per lapsum [74] et de statu innocentiae decidit, et de regno in creaturas. Utraque autem res etiam in hac vita nonnulla ex parte reparari potest; prior per religionem et fidem, posterior per artes et scientias. Neque enim per maledictionem facta est creatura prorsus et ad extremum rebellis. Sed in virtute illius diplomatis, *In sudore vultus comedes panem tuum*, per labores varios (non per disputationes certe, aut per otiosas ceremonias magicas), tandem et aliqua ex parte ad panem homini praebendum, id est, ad usus vitae humanae subigitur.

Finis Libri Secundi Novi Organi.

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[71] See Aph. 22.

[72] As I have already observed in a note on Aph. 21, 'ad concreta' seems to answer to the 'Variatio Inquisitionis pro Natura Subjecti' of that Aphorism, and, perhaps, 'Latentes Processus et Latentes Schematismi' to the 'Deductio ad Praxin.'

[73] These words are probably meant to correspond with the opening words of the Preface to the Instauratio Magna: 'De statu scientiarum, quod non sit foelix aut majorem in modum auctus; quodque alia omnino quam prioribus cognita fuerit via aperienda sit intellectui humano, et alia comparanda auxilia, ut mens suo jure in rerum naturam uti possit.'

[74] Cp. De Augm., lib. i. (E. and S., vol. i. p. 465), Preface to Instauratio Magna (p. 164), and Valerius Terminus (E. and S., vol. iii. pp. 217–8, 222).

[In the Original Edition, there here follow the PARASCEUE AD HISTORIAM NATURALEM ET EXPERIMENTALEM, and the CATALOGUS HISTORIARUM PARTICULARIUM, SECUNDUM CAPITA, referred to on pp. 296–7, and elsewhere. These, though of some interest, I have not thought it necessary to reproduce.]

INDICES.

INDEX TO THE INTRODUCTION.

N.B.—This Index does not extend to the Section on the Bibliography of the Novum Organum.

INDEX TO THE TEXT AND NOTES.

*** Words which occur in the Text only, or both in the Text and Notes, are printed in Roman type; those which occur in the Notes *only*, in Italics.

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